NATIONAL COMMUNICATIONS SYSTEM

TECHNICAL INFORMATION BULLETIN 96-5

MOBILE MULTIMEDIA COMMUNICATIONS

JUNE 1996

OFFICE OF THE MANAGER
NATIONAL COMMUNICATIONS SYSTEM
701 SOUTH COURT HOUSE ROAD
ARLINGTON, VA 22204-2198

19970516 012

97-J-1030

REPORT DOCUMENTATION PAGE

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	June 1996	Final Report

4. TITLE AND SUBTITLE

Mobile Multimedia Communications

5. FUNDING NUMBERS

DCA100-91-C-0031

6. AUTHOR(S)

Stephen Perschau

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

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8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

National Communications System
Office of Technology and Standards Division
701 South Court House Road
Arlington, Virginia 22204-2198

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

NCS TIB 96-5

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for public release; distribution is unlimited

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

This report is to summarize that status of the development of mobile video teleconferencing and interpret the relevance of this work to the federal government community. The report is divided into four main parts. It contains a review of all wireless networks shich could potentially be used for the video conferencing application. Mobile networks which are discussed included cellular (both analog and digital), cordless, wireless LANs, satellite, and Future Public Land Mobile Telecommunications System (FPLMTS), a discussion of the standards which are relevant to mobile video conferencing. There is also a presentation of the H.324 standard which is the basic architecture of the mobile multimedia terminal. The extension of H.324 to mobile networks is included. The status of the development of wireless multimedia terminals is discussed. The types of terminals covered include work accomplished in the European community, transmission via the analog AMPS network, terminals based o portable general purpose computer and special purpose devices. A review of the potential applications of wireless VTC in the federal government. Uses include teleconferencing, emergency/disaster relief and telemedecine.

14. SUBJECT TERMS

Multimedia Terminal
Wireless
Video TeleConferencing (VTC)

15. NUMBER OF PAGES

80

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASS	UNCLASS	UNCLASS	UNLIMITED

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NCS TECHNICAL INFORMATION BULLETIN 96-5

MOBILE MULTIMEDIA COMMUNICATIONS

JUNE 1996

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FOREWORD

Among the responsibilities assigned to the Office of the Manager, National Communications System, is the management of the Federal Telecommunication Standards Program. Under this program, the NCS, with the assistance of the Federal Telecommunication Standards Committee identifies, develops, and coordinates proposed Federal Standards which either contribute to the interoperability of functionally similar Federal telecommunication systems or to the achievement of a compatible and efficient interface between computer and telecommunication systems. In developing and coordinating these standards, a considerable amount of effort is expended in initiating and pursuing joint standards development efforts with appropriate technical committees of the International Organization for Standardization, and the International Telegraph and Telephone Consultative Committee of the International Telecommunication Union. This Technical Information Bulletin presents an overview of an effort which is contributing to the development of compatible Federal, national, and international standards in the area of video teleconferencing. It has been prepared to inform interested Federal activities of the progress of these efforts. Any comments, inputs or statements of requirements which could assist in the advancement of this work are welcome and should be addressed to:

> Office of the Manager
> National Communications System
> Attn: N6
> 701 S. Court House Road
> Arlington, VA 22204-2198

MOBILE MULTIMEDIA COMMUNICATIONS

FINAL REPORT

CONTRACT DCA100-91-C-0031

Submitted to:
NATIONAL COMMUNICATIONS SYSTEM
ARLINGTON, VA

January 3, 1996

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1   INTRODUCTION

This document summarizes work performed by Delta Information Systems, Inc. (Delta) for the National Communications Systems (NCS), Office of Technology and Standards. The NCS is responsible for the management of the Federal Telecommunications Standards Program, which develops telecommunications standards, whose use is mandatory for all Federal departments and agencies.

This document is a final report for a Task Order on Contract DCA100-91-C-0031. The titles for the contract and Task Order are listed below.

- Contract DCA100-91-C-0031
  Development of Federal Telecommunication Standards Relating to Digital Facsimile and Video Teleconferencing

- Task No. 2
  Technical Work in the Area of Video Teleconferencing

- Subtask No. 2
  Mobile Multimedia Communications

Video TeleConferencing (VTC) is being widely deployed throughout the federal government, achieving great benefits in productivity and timeliness of decisions. The deployment has resulted from the maturity of video teleconferencing standards, the primary example being the H.320 series of ITU Recommendations.

The ITU has recently completed the new H.324 set of standards to enable video conferencing over the PSTN [Public Switched Telephone Network]. This new H.324 terminal will bring a whole new set of capabilities and facilities to the federal government community. Typical new applications include telecommuting, disaster recovery, surveillance, and the ability for federal workers to easily access each other on a global basis. The ITU is also working on a new set of standards [H.324M] which will adapt the H.324 Recommendations from the PSTN for use on the mobile network environment. This set of mobile VTC standards, which is due for completion in 1996, will open up an entire new dimension of telecommunications for the federal government community. One issue which should be noted is that VTC, whether it be mobile or otherwise, does not require motion video to be part of the transmission. The H.324 and H.324M standards define multimedia terminals which provide for any combination of speech, data, and video communications. These terminals provide for interactive conversational services as well as non-conversations services such as the access of information [e.g. computer graphics, documents, still pictures, motion video] from data bases.

The purpose of this report is to summarize that status of the development of mobile video teleconferencing and interpret the relevance of this work to the federal government community. The report is divided into four main parts. Section 2.0 contains a review of all wireless networks which could potentially be used for the video conferencing application. Mobile networks which are discussed include cellular [both analog and digital], cordless, wireless LANs, satellite, and FPLMTS [Future Public Land Mobile Telecommunications System]. In Section 3.0 there is a discussion of the standards which are relevant to mobile video conferencing. First, there is a presentation of the H.324 standard which is the basic architecture of the mobile multimedia terminal. Next the status of H.324M, the extension of H.324 to mobile networks, is presented. Other items include standards related to data base access as well as long term standards investigations which are underway.

The status of the development of wireless multimedia terminals is discussed in Section 4.0. The types of terminals covered include work accomplished in the European community, transmission via the analog AMPS network, terminals based on portable general purpose computers [notebooks, PDA's, etc.], and special purpose devices. Section 5.0 contains a review of the potential applications of wireless VTC in the federal government. Uses include teleconferencing, emergency/disaster relief, telemedecine, law enforcement, remote maintenance/ diagnostics, and surveillance. Finally conclusions and recommendations are provided in Section 6.0.

2   WIRELESS NETWORKS

Wireless networks can be classified according to the size of the zone they serve; [1] Global/national, [2] Mobile [town, highway], [3] Local [shopping mall], [4] Indoor/LAN. Table 2-1 is a summary of the key characteristics of these four types of wireless networks. Mobile networks dominate wireless communications today with approximately 13 million subscribers in the United States. Although most prevalent wireless networks in use today are analog, and voice oriented [e.g. the AMPS-Advanced Mobile Phone service], there is a great deal of work going on in the digital wireless area. Again, much of the digital wireless work remains focused on voice communications [GSM in Europe, IS-54 in the U.S., JDC in Japan].

Table 2-1

	Global/National	Mobile	Local	WL/LAN
Terminal Location	Anywhere	Vehicle, Urban, Suburban	Shopping mall, transportation	In building
Cell Range	Hundreds of Miles	1-20 mi.	< 1 mi.	Hundreds of feet
Cell Descriptor	Megacell	Macrocell	Microcell	Pico cell
Bit Rate	Low	$\leq$ 19.2 Kbps	Medium	High
Mobility		High speed vehicle	Low speed	Low
Example	Iridium	Analog - AMPS Digital -	Future - PCS Analog - Cordless	

2.1   Cellular
2.1.1   Analog Cellular System

Cellular radio can be regarded as the earliest form of wireless "personal communications." It allows the subscriber to place and receive telephone calls over the wireline telephone network wherever cellular coverage is provided. All of these "first-generation" cellular systems use analog frequency modulation (FM) for speech transmission and frequency shift keying (FSK) for signaling. Individual calls use different frequencies. This way of sharing spectrum is called frequency division multiple access (FDMA).

The distinguishing feature of cellular systems compared to previous mobile radio systems is the use of many base stations with relatively small coverage radii, on the order of 10 km or less.

In cellular systems, continuous coverage is achieved by executing a "handoff" (the seamless transfer of the call from one base station to another) as the mobile unit crosses cell "boundaries." This requires the mobile to change frequencies under control of the cellular network. The U.S. standard for analog cellular is known as AMPS (Advanced Mobile Phone Service), and there are now 8 million AMPS subscribers.

2.1.2 Digital Cellular Systems

The development of low-rate digital speech coding techniques and the continuous increase in the device density of integrated circuits (i.e., transistors per unit area), have made completely digital second-generation cellular systems viable. Digitization allows the use of time division multiple access (TDMA) and code division multiple access (CDMA) as alternatives to FDMA. With TDMA, the usage of each radio channel is partitioned into multiple timeslots, and each user is assigned a specific frequency/timeslot combination. Thus, only a single mobile in a given cell is using a given frequency at any particular time. With CDMA (which uses direct sequence spreading), a frequency channel is used simultaneously by multiple mobiles in a given cell, and the signals are distinguished by spreading them with different codes.

2.1.2.1   IS-54 in North America

In the U.S., the Electronic Industries Association (EIA) and the Telecommunications Industry Association (TIA) have adopted the IS-54 digital cellular standard based on TDMA. IS-54 retains the 30 KHz channel spacing of AMPS to facilitate evolution from analog to digital systems. Each user channel is allocated 16 Kbps; 3 Kbps for control and 13 Kbps for speech including error control.

Since systems using the IS-54 standard must operate in the same spectrum used by the existing AMPS systems, the IS-54 standard is "dual mode," meaning that it provides for both analog (AMPS)and digital operation. This is necessary to accommodate "roaming" subscribers, given the large embedded base of AMPS equipment. Although service providers have already begun to deploy IS-54 equipment in major metropolitan areas in the United States, the conversion to digital will be slower in less dense areas. Consequently, there will be a mix of analog and digital terminals as well as base station equipment for a considerable period of time.

2.1.2.2   IS-95 in North America

The EIA/TIM IS-95 standard is based on the CDMA system. With IS-95, many users share a common channel for transmission. The basic user channel rate is 9.6 kb/s. This is spread to a channel chip rate of 1.2288 Mchip/s (a total spreading factor of 128) using a combination of techniques. Each mobile in a given cell is assigned a different spreading sequence, providing perfect separation among the signals from

different users, at least for a single-path channel. At both the base station and the mobile, RAKE receivers are used to resolve and combine multipath components, significantly reducing the fading amplitude.

Like IS-54, IS-95 is compatible with the IS-41 signaling protocol, and is a dual-mode standard designed for the existing North American cellular bands; IS-95 terminals can operate either in the CDMA mode or the AMPS mode. Deployment of IS-95 systems in the Los Angeles, California area is expected this year.

2.1.2.3   PCS (Personal Communication System)

In the U.S., the FCC has taken the initiative to arrange for the development of PCS. Based on this work, it is anticipated that some PCS capability may be fielded toward the end of 1995.

On September 23, 1993, the U.S. FCC authorized the use of spectrum in the 1850 to 2200-MHz "Emerging Technologies" band for wideband personal communications (often referred to as the "2 GHz" band). The plan was modified on June 9, 1994 to focus on the 1850-to-1990-MHz band. The FCC allocated a total of 120 MHz for licensed PCS at 1850 to 1910 MHz and 1930 to 1990 MHz. Unlicensed PCS is allocated 20 MHz at 1910 to 1939 MHz. The key wireless system interfaces for which standards are being developed are: between the radio terminal and the access system (the "air" interface), between the radio access system and the switch, between the switch and the database, and between PCS systems.

Work on PCS standards is underway at both the national and international level. In the United States, three voluntary standards organizations -- Committee T1, the Telecommunications Industry Association (TIA) and IEEE (through standards committees such as 802.11), all accredited by the American National Standards Institute (ANSI) -- are jointly and separately developing various standards and reports which will influence and guide the deployment of PCS systems in the United States.

Committee T1 is organized into six Technical Subcommittees (TSC). The primary focus for PCS standards is TSC T1P1, which was formed in 1990 and has responsibility for service descriptions, system and service objectives, privacy and authentication, architecture and air interface standards, as well as overall Program Management for PCS standards development. T1S1 is developing signaling protocols to support PCS, and T1A1 has developed transmission performance guidelines for speech and voiceband data. A standard for the operation, administration, maintenance and provisioning (OAM&P) of PCS systems has been developed in T1M1. Currently, the TSCs in T1 are cooperatively working on the development of complete service descriptions and signaling protocols for basic, bearer, and supplementary services.

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TIA is organized into four divisions, each of which has several associated Engineering Committees responsible for standards development. In the Mobile & Personal Communications Division, wireless standards are developed for 2-GHz PCS, 800-Mhz cellular, 900-Mhz specialized mobile radio and 46/49 and 900-Mhz cordless. The focus for 2-GHz PCS standards is Engineering Committee TR46, which was formed in early 1993. Within TR46 are four subcommittees that address PCS services and network reference models, system and network interfaces, networking signaling, air interfaces, and privacy and authentication.

TR46 works closely with Committee T1 through a Program Management team (PMT) to coordinate joint activities and to avoid duplication of effort. The PMT has issued a comprehensive plan for PCS standards development. In 1992 T1P1 and TR46 formed a unique structure, the Joint Technical Committee (JTC) on Wireless Access, to combine the two groups' expertise in order to develop a common set of air interface standards for the licensed and unlicensed portions of the 2-GHz band. The TJTC consists of Working Group T1P1.4 and Task Group TR46.3.3. The JTC's mission is to develop standards and technical reports concerning user access to telecommunications networks through interfaces associated with wireless services and PCS. The JTC is an innovation in the cooperative activities of Committee T1 and TIA, which reduces duplicative activity and meets industry needs.

In March 1994, technical ad-hoc groups (TAGs) were organized for seven PCS proposals. Table 2-2, taken from a presentation given at the National Engineering Consortium WPC Teleforum III, provides a brief summary of some of the technical characteristics of these interfaces.

Table 2-2 Summary of Technical Characteristics

	TAG-1	TAG-2	TAG-3	TAG-4	TAG-5	TAG-6	TAG-7
Parameter	New	15-95-Based	PACS	15-54-based	DCS-based	DCT-based	W-CDMA
Access Method	CDMA/TDMA/ FDMA	CDMA	TDM/TDMA	TDM/TDMA	TDMA	TDMA	D-CDMA
Duplex Method	TDD	FDD	FDD	FDD	FDD	TDD	FDD
Bandwidth	5 MHz	1.25MHz	300kHz	30kHz	200kHz	1728kHz	5MHz
Bit rate (no overhead)	32 kb/s	8/13.3 kb/s	32 kb/s	7 kb/s	13 kb/s	32 kb/s	32 kb/s
Process gain	21 dB	21 dB	NA	NA	NA	NA	21 dB
Channel spacing	5 MHz	1.25 MHz	200 kHz	30 kHz	200 kHz	1728 kHz	5 MHz
Voice channels/carrier 32 (8kb/s CELP) SHO = soft handover	20 (eff) + SHO	8	3	8	12	128 (less SHO)	
Reference to AMPS	16X	10X	0.8X	3X	2-3X	0.2X	16X (less SHO)
Modulation	Cont. Ph. Shift QM	PQPSK/QPSK	Pi/4 d-QPSK	GMSK	GFSK	PQPSK/QPSK	

	TAG-1	TAG-2	TAG-3	TAG-4	TAG-5	TAG-6	TAG-7
Error control (voice)	None	FEC	None	FEC	FEC	None	FEC
Frequency Reuse (N)	3	1	16X1	7X3	7X1 and 3X3	9	1
Max. avg. subscriber power	-	200 mW	12.5 mW	100 mW	125 mW	20.8	500 mW
SU power in timeslot	1W	-	100 mW	600 mW	1 W	250 mW	
Time frame length	625 ms	-	312.5 ms	6.7	577 ms	417 ms	
Timeslot length	80 ms	50 ms	9 ms	110 ms	90 ms	28 ms	13.25 ms
End-to-end speech delay	80 ms	50 ms	9 ms	110 ms	90 ms	28 ms	13.25 ms
Equalizer	No	No	No	Yes	Yes	No	No
Vocoder	CELP (8 kb/s) ADPCM (16, 25, 32, 50 kb/s)	Var. rate (8/4/2/1)	ADPCM (32 kb/s)	VSELP (8kb/s) LDCELP (16 kb/s)	RPE-LTP (13 kb/s)	ADPCM (16-32 kb/s)	ADPCM (32 kb/s)

Source: taken from a presentation give at the National Engineering Consortium WPC Teleforum III [9].

To minimize political influences, the JTC has associated the activities of the TAGs with technologies rather than company proposals. The proposals can be characterized as follows:

TAG-1 (new): a composite 5 MHz CDMA/TDMA/FDMA air interface for large cell licensed-band applications, and small-cell, unlicensed-band applications. The basis of this proposal is derived from technology that resulted in the FCC awarding a "Pioneer's Preference" to Omnipoint Corporation.

TAG-2 (IS-95-based): a 1.25-MHz CDMA air interface for large cell applications. The basis of this proposal is derived from the 800-MHz Cellular EIA/TIA Interim Standard, IS-95.

TAG-3 (Personal Access Communications System, or PACS): an eight-timeslot TDMA air interface with an FDD mode for small cell licensed-band applications and a TDD mode for small-cell, unlicensed-band applications. The basis of this proposal is derived from *Wireless Access Communications System (WACS)* developed by Bellcore, and *Personal Handy Phone* developed in Japan.

TAG-4 ((S-54 based): a three-timeslot TDMA air interface for large-cell, licensed-band applications. The basis of this proposal is derived from the 800 MHz Cellular EIA/TIA Interim Standard, IS-54.

TAG-5 (DCS-based): an eight-timeslot TDMA air interface for large-cell, licensed-band applications. The basis of this proposal is derived from DCS 1800, which is a frequency shifted derivative of GSM. GSM is a widely deployed European Cellular System developed by ETSI.

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The proposal has the potential of adding timeslot aggregation capabilities to support higher data rates. Multiple vocoders are supported. The proposal is essentially the same as DCS 1800 systems currently deployed in Europe.

TAG-6 (DCT-based): a 12-timeslot TDMA air interface for small-cell, licensed-band applications. The basis of this proposal is derived from Digital European Cordless Telephone (DECT).

The proposal is essentially the same as existing DECT systems in Europe, and appears to work well in office and indoor environments. Modifications are being considered to make the interface more viable outdoors. The proposal will comply with the spectrum etiquette for operation in the unlicensed PCS band.

TAG-7 (W-CDMA): a 5-MHz CDMA air interface for large- and small-cell licensed-band applications. The basis of this proposal is derived from wideband CDMA technologies of OKI and InterDigital.

The proposal is looking at the feasibility of noise cancellation techniques to further increase the capacity of CDMA systems. It also supports flexible aggregation of traffic channels within an RF channel to support higher data rates.

It is useful to divide the PCS proposals into two broad categories--high-tier and low-tier. High tier basically refers to "cellular" systems which are characterized by high power, voice communications, mobile vehicular applications, and relatively low bit rate. Table 2-3 provides information on four high-tier systems three of which are TAG-2, TAG-4, and TAG-5 [IS-95, IS-54, and GSM respectively]. The low-tier systems are characterized below, and several examples are listed in Table 2-3 including the TAG-3 and TAG-6 systems [WACS/PACS, and DECT respectively].

- 32 kb/s ADPCM speech encoding to take advantage of the low complexity and low power consumption, and to provide low-delay high-quality speech.
- Flexible radio link architecture that will support multiple data rates from several kb/s to several hundred kb/s.
- Low transmitter power ($\leq$ 25 mW average) with adaptive power control to maximize talk time and data transmission time.
- Low complexity signal processing to minimize power consumption. Complexity one-tenth that of digital cellular or high-tier PCS technologies is an objective.
- Low co-channel interference and high coverage area design criteria. In order to provide high-quality service over a large region, at least 99 percent of any covered area must receive good or better coverage, and be below acceptable co channel interference limits. This implies less than 1 percent of a region will receive marginal service. This is an order-of-magnitude higher service requirement than the ten percent of a region

permitted to receive marginal service in vehicular cellular system (high-tier PCS) design criteria.

Such technologies and systems have been designed, prototyped, and laboratory-and field-tested and evaluated for several years. This dual-tier viewpoint is consistent with the progress in the Joint Technical Committee (JTC) of the U.S. standards bodies, Telecommunications Industry Association (TIA) and Committee T1 of the Alliance for Telecommunications Industry Solutions (ATIS). Many technologies and systems were submitted to the JTC for consideration for wireless PCS in the new 1.9 GHz frequency bands for use in the United States. It was evident that there were at least two, and perhaps three distinct different classes of submissions.

One class of submissions was the group labeled High Power Systems, Digital Cellular (High-Tier PCS) in Table 2-3. They are highly optimized for low bit-rate voice, and therefore have somewhat limited capability for serving packet-data applications. There are more than 100 million vehicles in the United States alone. In the future, most, if not all, of these will be equipped with high-tier cellular mobile phones. Therefore, there will be a continuing and rapidly expanding market for high-tier systems.

Another class of submissions to the JTC including the Japanese Personal Handiphone System (PHS), and a technology and system originally developed at Bellcore, but carried forward to prototypes, and submitted to the JTC, by Motorola and Hughes Network Systems. This system was known as Wireless Access Communications System (WACS). These two submissions were so similar in their design objectives and system characteristics that, with the agreement of the delegations from Japan and the United States, the PHS and WACS submissions were combined under a new name, Personal Access Communication Systems (PACS), that was to incorporate the best features of both. This advanced, low-power wireless access systems, PACS, was to be know as low-tier PCS.

Table 2-3 Wireless PCS Technologies

| | High Power Systems Digital Cellular (High Tier PCS) | | | | Low Power Systems | | | |
					Low Tier PCS		Digital Cordless	
System	IS-54	IS-95 (DS)	GSM	DCS-1800	WACS/PACS	Handi-Phone	DECT	CT-2
Multiple Access	TDMA/FDMA	CDMA/FDMA	TDMA/FDMA	TDMA/FDMA	TDMA/FDMA	TDMA/FDMA	TDMA/FDMA	FDMA
Fre. band (MHz) Uplink (MHz) Downlink (MHz)	869-894 824-849 (USA)	869-894 824-849 (USA)	935-960 890-915 (Eur.)	1710-1785 1805-1880 (UK)	Emerg. Tech' (USA)	1895-1907 (Japan)	1880-1900 (Eur.)	864-868 (Eur. and Asia
FR Ch. spacing Downlink (KHz) Uplink (KHz)	30 30	1250 1250	200 200	200 200	300 300	300	1728	100
Modulation	π/4 DQPSK	BPSK/QPSK	GMSK	GMSK	π/4 QPSK	π/4 DQPSK	GFSK	GFSK
Portable Txmit Power, max/avg	600 mW/ 200 m/W	600 m/w	1 W/ 125 mW	1 W/ 125 mW	200 mW/ 25 m/W	80 mW/ 10 mW	250 mW/ 10 mW	10 mW/ 5 mW
Speech coding	VSELP	QCELP	RPE-LTP	RPE-LTP	ADPCM	ADPCM	ADPCM	ADPCM
Speech rate (kb/s)	7.95	8 (var.)	13	13	32/16/8	32	32	32
Speech ch/FT ch.	3	-	8	8	8/16/32	4	12	1
Ch. bit rate (kb/s) Uplink (kb/s) Downlink(kb/s)	48.6 48.6		270.833 270.833	270.833 270.833	384 384	384	1152	72
Ch. coding	½ rate conv.	½ rate fwd. 1/3 rate rev	½ rate conv.	½ rate conv.	CRC	CRC	CRC (control)	None
Frame (ms)	40	20	4.615	4.615	2.5	5	10	2

*Spectrum is 1.85 to 2.2 Ghz allocated by the FCC for emerging technologies; DS is direct sequence

In the JTC, submissions for PCS or DECT and CT-2 and their variations are also lumped under the class of low-tier PCS, even though these advanced digital cordless telephone technologies were somewhat more limited in their ability to serve all of the low-tier PCS needs.

2.2   Cordless Telephony
2.2.1   First-Generation Analog Cordless

Since 1984, analog cordless telephones in the United States have operated on ten frequency pairs in the bands 46.6-47.0 MHz (base transmit) and 49.6-59.0 MHz (handset transmit). The allowed emission bandwidth is 20 KHz, and the effective radiated power (ERP) is very low, roughly 20 μ W (compared to 10 mW for most other cordless telephone systems). Analog FM is used for the voice signal, and the U.S.

Federal Communications Commission (FCC) rules require digital coding of the signaling functions for security. There are an estimated 60 million 46/49 KHz cordless telephones in use in the United States, and total sales are roughly 15 million units per year. Despite the recent availability of higher-power digital cordless telephones operating in the 915 MHz Industrial, Scientific, and Medical (ISM) band, the popularity of 49 MHz analog cordless telephones is expected to continue for a considerable time due to their low cost (U.S. $50 to $100 is typical for a basic unit).

Because of the large embedded base of these devices, the existing ten channel pairs have become inadequate, particularly in high-density areas. In August 1992, the TIA petitioned the FCC to make 15 additional frequency pairs near 44 MHz (base transmit) and 49 MHz (handset transmit) available for cordless telephones. In August 1993, the FCC adopted a Notice of Proposed Rule Making (NPRM) in response to TIA's petition, proposing specific provisions to be added to the FCC Rules. A final ruling on the new frequencies by the FCC is expected this year.

In the United States, Bell Communications Research (Bellcore) developed an air interface for Wireless Access Communications Systems (WACS). This interface is intended to provide wireless connectivity to the local exchange carrier (LEC), and is designed with low-speed portable applications and small-cell systems in mind. Base stations are envisioned as shoebox-sized enclosures mounted on telephone poles, separated by about 600 m. The WACS air interface is similar to the digital cordless interfaces, with two notable exceptions: frequency-division duplexing (FDD) is used rather than time division duplexing (TDD), and greater effort has been made to optimize the link budget and frequency reuse.

As part of the standards process in the United States related to the recently-allocated spectrum near 2 GHz for Personal Communications Services (PCS), attributes of WACS and PHS have been combined to create an industry standard proposal for Personal Access Communications Services (PACS). PACS is intended as a "low-tier" air interface for the licensed portion of the new 2-GHz spectrum.

2.2.2 Digital Cordless Compared to Digital Cellular

From the foregoing summaries of the various digital cordless air interfaces, it is clear that while there are significant differences among them, they have a number of characteristics in common which distinguish them from the digital cellular technologies discussed earlier. In general, the digital cordless systems are optimized for low-complexity equipment and high-quality speech in a quasi-static environment (with respect to user mobility). Conversely, the digital cellular air interfaces are geared toward maximizing bandwidth efficiency and frequency reuse in a macrocellular, high-speed fading environment. This is achieved at the price of increased complexity in the terminal and base station. As summarized in Table 2-4, the physical layer parameters for digital cordless and digital cellular technologies reflect these respective design objectives.

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Table 2-4 General Comparison of Digital Cordless and Digital Cellular Air Interfaces

	Digital Cordless	Digital Cellular
CHARACTERISTICS		
Cell size	small (50 to 500 m)	large (0.5 to 30 km)
Antenna elevation	low (15m or less)	high (15m or more)
Mobility speed	low (6kph or less)	high (up to 250 kph)
Coverage	zonal	wide-area continuous
Handset complexity	low	moderate
Base complexity	low	high
Spectrum access	shared	exclusive
DESIGN ATTRIBUTES		
Handset TX power (average)	5 to 10 mW	100 to 600 mW
Duplexing	TDD*	FDD
Speech coding	32kb/s ADPCM	8 to 13 kb/s vocoder
Error control	CRC	FEC/interleaving
Detection	discrim/differential*	coherent/differential
Multipath mitigation	antenna diversity (opt.)	diversity/equalizer/Rake

* PACS uses frequency duplexing and coherent detection.

2.3   Wireless LANs

Wireless local-area data networks (WLANs) can be characterized as providing low-mobility high-speed data communications within a confined region, e.g., a campus or a large building. Coverage range from a wireless data terminal is short, tens to hundreds of feet, like cordless telephones. Coverage is limited to within a room or to several rooms in a building. WLANs have been evolving for a few years, but overall, the situation is chaotic, with many different products being offered by many different vendors. There is no stable definition of the needs or design objectives for WLANs, with data rates ranging from hundreds of kb/s to more than 10 MB/s wireless link rates. An IEEE standards committee, 802.11, has been attempting to put some order into this topic, but their success has been somewhat limited. A partial list of some advertised products is given in Table 2-5. Users of WLANs are not nearly as numerous as the users of more voice-oriented wireless systems. Part of the difficulty stems from these systems being driven by the computer industry that views the wireless system as just another plug-in interface card, without giving sufficient consideration to the vagaries and needs of a reliable radio system.

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Table 2-5 Partial List of WLAN Products

Product Company Location	Freq. (MHz)	Link rate	User rate	Protocol (s)	Access	No. of chan or spread factor	Mod./coding	Power	Network topology
Altair Plus II Motorola Arlington Hts., IL	18-19 Ghz	15 Mb/s	5.7 Mb/s	Ethernet			4-level FSK	25 mW peak	Eight devices/radio; radio to base to Ethernet
WaveLAN NCR/AT&T Dayton, OH	902-928	2 Mb/s	1.6 Mb/s	Ethernet-like	DS SS		DQPSK	250 mW	Peer-to-peer
AirLAN Solectek San Diego, CA	902-928		2 Mb/s	Ethernet	DS-SS		DQPSK	250 mW	PCMCIA w/ant;radio to hub
Free[prt Windata Inc. Northboro, MA	902-928	16 Mb/s	5.7 Mb/s	Ethernet	DS SS	32 chips/bit	16 PSK trellis coding	650 mW	Hub
Intersect Persoft Inc. Madison, WI	902-928		2 Mb/s	Ethernet, token-ring	DS SS		DQPSK	250 mW	Hub
LAWN O'Neill Comm Horsham, PA	902-928		38.4kb/s	AX.25	SS	20 users/chan.; max 4 chan.		20 mW	Peer-to-peer
WiLan WiLan Inc. Calgary, Alberta	902-928	20 Mb/s	1.5 Mb/s/chan	Ethernet, token ring	CDMA/ TDMA	3 chan. 10-15 links each	"unconventio nal"	20 mW	Peer-to-peer
RadioPort ALPS Electric USA	902-928		242kb/s	Ethernet	SS	?/3 channels		100 mW	Peer-to-peer
ArLan 600 Telesys. SLW Don Mill, Ont.	902-928 2.4 GHz		1.35 Mb/s	Ethernet	SS			1 W max	PCs with ant.; radio to hub
RadioLink Cal. Microwave Sunnyvale, CA	902-928 2.4 GHz	250 kb/s	64 kb/s		FH SS	250 ms/hop 500 kHz space			Hub
Range LAN Proxim, Inc. Mountainview, CA	2.4 GHz	1Mb/s/ adaptor		Ethernet token ring	DS SS	3 chan.		100 mW	
Range LAN2 Proxim, Inc. Mountainview, CA	2.4GHz	1.6 Mb/s	50 kb/s max	Ethernet token ring	FH SS	10 chan @ 5 kb/s; 15 sub-ch. each		100 mW	Peer-to-peer bridge
Netwave Xircom	2.4GHz	1 Mb/s/ adaptor		Ethernet token ring	FH SS	81 1 MHz chan. or "hops"			Hub
Freelink Cabletron Sys. Rochester, NJ	2.4 and 5.8 GHz		5.7 Mb/s	Ethernet	DS SS	32 chips/ bit	16 PSK trellis coding	100 mW	Hub

There are two overall network architectures pursued by WLAN designers. One is a centrally coordinated and controlled network that resembles other wireless systems. There are base stations in these networks that exercise overall control over channel access. The other type of network architecture is the self organizing and distributed controlled network where every terminal has the same function as every other terminal, and networks are formed ad-hoc by communications exchanges among terminals. Such ad-hoc networks are more like citizen band (CB) radio networks, with

similar expected limitations if they were ever to become very widespread. Nearly all WLANs in the United States have attempted to use one of the ISM frequency bands for unlicensed operation under part 15 of the FCC rules. These bands are 902 to 928 MHz, 2400 to 2483.5 MHz, and 5725 to 5850 MHz, and they require users to accept interference from any interfering source that may also be using the frequency.

2.4 Mobile Satellite Services

There are some situations in which providing radio coverage with cellular-like terrestrial wire-less networks is either not economically viable (such as in remote, sparsely-populated areas), or physically impractical (such as over large bodies of water). In these cases, mobile satellite services (MSS) could fill the gap, allowing complete global coverage. Spectrum has been designated by the ITU for MSS, and there are many MSS systems in various stages of concept, design, and operation. Some support only data services while others accommodate voice as well. Some are designed for special purposes and/or private user groups while others are intended for general (public) use and interconnection to the PSTN. The later could support universal wireless communications.

One way to broadly categorize MSS systems is according to the orbital altitude of the satellites: geostationary satellites (GEOS), at an altitude of 35,786 km; low earth orbit satellites (LEOS), at altitudes on the order of 1,000 km; medium earth orbit satellites (MEOS), at altitudes on the order of 10,000 km; and highly elliptical orbit satellites (HEOS), with widely varying altitudes. GEOS systems for public use include INMARSAT-M, MSAT, ACTS, MOBILESAT, and NSTAR. LEOS systems include Iridium (66 satellites at roughly 770 km), Globalstar (48 satellites at 1400 km), and Teledesic (840 satellites at 700 km). Odyssey is a MEOS proposal with 12 satellites at about 10,600 km, and the ELMSAT proposal specifies a HEOS approach with two or three satellites.

2.5 FPLMTS (Future Public Land Mobile Telecommunication Systems)

The World Administrative Radio Conference (WARC) of the International Telecommunication Union (ITU), in March 1992, identified global bands 1885-2025 MHz and 2110-2200 MHz for Future Public Land Mobile Telecommunication Systems (FPLMTS), including 1980-2010 MHz and 2170-2200 MHz for the mobile satellite component.

The potential for all FPLMTS radio interfaces to be in the same frequency band world-wide provides a strong incentive to work towards ITU global standards which maximize radio commonality, in particular that between the satellite and terrestrial components of FPLMTS. This will simplify mobile equipment for operation in multiple FPLMTS radio operating environments.

FPLMTS are third-generation global systems that aim to unify the diverse systems we see today into a seamless radio infrastructure capable of offering a wide range of services, with the quality we have come to expect from the fixed telecommunications networks around the year 2000 in many different radio environments.

Third-generation mobile communications systems are one step beyond the digital cellular and cordless systems now coming into service, and will provide the capability to deliver voice, video, and data communications between people and/or machines *anywhere -- anytime.*

The first- and second-generation mobile systems we see today each only cover a limited range of radio operating environments so that a complex multimode mobile unit would be needed to ensure that one could really be reached anywhere -- anytime. Not only are the frequency bands and standards used by these earlier mobile systems different for the various environments, e.g., terrestrial, satellite, etc., but the range of services available and their quality are significantly less than those envisaged for FPLMTS.

The FPLMTS vision goes well beyond the individual capabilities of both wireless access and personal telecommunications.

Personal telecommunications involves providing an essentially transparent connection so that a practical range of "personalized" telecommunications services can be automatically provided to people on the move, wherever they may be. Both wired and wireless access can be involved, with existing infrastructures forming the basis for seamless call delivery to a person rather than a place.

The ITU concept of universal personal telecommunications (UPT) is based on the use of a personal number to allow communications with the network interface currently selected by the customer. This clearly complements the wireless mobility offered by FPLMTS radio networks giving the customer total mobility across many wired and wireless networks.

3   MOBILE MULTIMEDIA TERMINAL STANDARDS

There is considerable activity by the two primary international communications standards organizations [ITU-International Telecommunications Union, ISO-International Standards Organization] to develop standards defining a mobile multimedia terminal. The standards work is divided into the four sequential phases listed below and described in the following sections.

BASIC ARCHITECTURE FOR LOW BIT RATE MULTIMEDIA TERMINAL (H.324)- The ITU-T has recently completed a set of Recommendations defining a multimedia terminal for transmission at very low bitrates, but with particular emphasis for the PSTN [Public Switch Telephone Network]. Since the maximum PSTN transmission bitrate is 28.8 Kbps, this standard is directly applicable to the mobile application where the bitrate is equally restricted. The key standard which describes the integrated audiovisual terminal is H.324. Other standards in the set cover video coding [H.263], speech coding [G.723.1], communication protocol [H.245], and multiplex [H.223]. The H.324 terminal also includes the provision for the transmission of data (e.g. still picture, computer graphics) in addition to speech and video signals. ITU-T Recommendation T.120 defines the procedures for this "data" transmission.

EXTENSION OF H.324 TO THE MOBILE ENVIRONMENT- The ITU-T is actively developing new Recommendations to extend the H.324 set of standards to the mobile environment. The key aspect of this work is the adaptation of the H.324 standards for operation under the very poor transmission error conditions which characterize mobile communications.

DATA BASE ACCESS- One the most important applications of the mobile multimedia terminal is the access of information from a remote data base. Examples of data to be accessed include drawings, video clips, documents, photographs, etc. These non-conversational services ease some of the coding constraints (e.g. delay), but it necessitates the development of standards to command and control the remote data base server. Work is underway by ISO and the ITU to fulfil this requirement.

LONG TERM ACTIVITIES- The G.723.1 speech coding standard operates at bit rates of 5.3 and 6.3 Kbps and provides near toll quality. The ITU-T is working on a new Recommendation, with a target completion date of 1998, which will provide toll quality at 4.0 Kbps. The H.263 video coding standard provides a significant improvement in picture quality relative to the H.261 Recommendation which was established in 1990. The ITU-T and ISO have initiated a joint project to investigate advanced video coding to provide a significant improvement over H.263.

## 3.1   H.324; Terminal for Low Bitrate Multimedia Communication

In September, 1993 the ITU established a program to develop an international standard for a multimedia terminal operating over the public switched telephone

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network. A major milestone in this project was accomplished in November, 1995, when the ITU determined that the multimedia terminal Draft Recommendation H.324 was approved for ballot. It is anticipated that the standard will be fully approved in March, 1996. The H.324 terminal will have two principal applications: [1] a conventional videophone used primarily by the consumer, [2] a multimedia system to be integrated into a personal computer for a range of business purposes, for example, telecommuting.

The ITU has also approved the four major functional elements of the H.324 terminal to begin the ballot process; [1] G.723.1 speech coder, [2] H.263 video coder, [3] H.245 communication controller, [4] H.223 multiplexer. The quality of the speech provided by the new G.723 audio coder, when operating at only 6.3 kilobits per second, is very close to that found on a conventional phone call. The picture quality, produced by the new H.263 video coder, shows promise of significant improvement relative to many earlier systems. It is anticipated that these technical advances, when combined with the high transmission bit rate of the V.34 modem [28.8 kilobits/sec. maximum], will yield an overall audiovisual system performance which is significantly improved relative to earlier videophone terminals.

3.1.1 H.324 (Multimedia Telecommunications Operating Over the PSTN)

Recommendation H.324 defines a multimedia communication terminal (an H.324 terminal) operating over the Public Switched Telephone Network (PSTN). The H.324 document refers to other ITU Recommendations, illustrated in Figure 3.1, which collectively define the complete terminal. Four new companion Recommendations include: H.263 (Video Coding at Rates Less Than 64 kbit/s), G.723 (Speech Coder for Multimedia Telecommunications Transmitting at 5.3/6.3 kbit/s), H.223 (Multiplexing Protocol for Low Bitrate Multimedia Terminals), H.245 (Control of Communications between Multimedia Terminals). H.324 specifies use of the V.34 modem, which operates up to 28.8 kbit/s, and the V.8 (or V.8bis) procedure to start and stop data transmission. An optional data channel is defined to provide for the exchange of computer data in the workstation/PC environment. H.324 specifies the use of the T.120 protocol as one possible means for this data exchange. Recommendation H.324 defines the seven phases of a call: set-up, speech only, modem training, initialization, message, end, clearing.

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AREAS FOR TSS STANDARDIZATION (H.324)
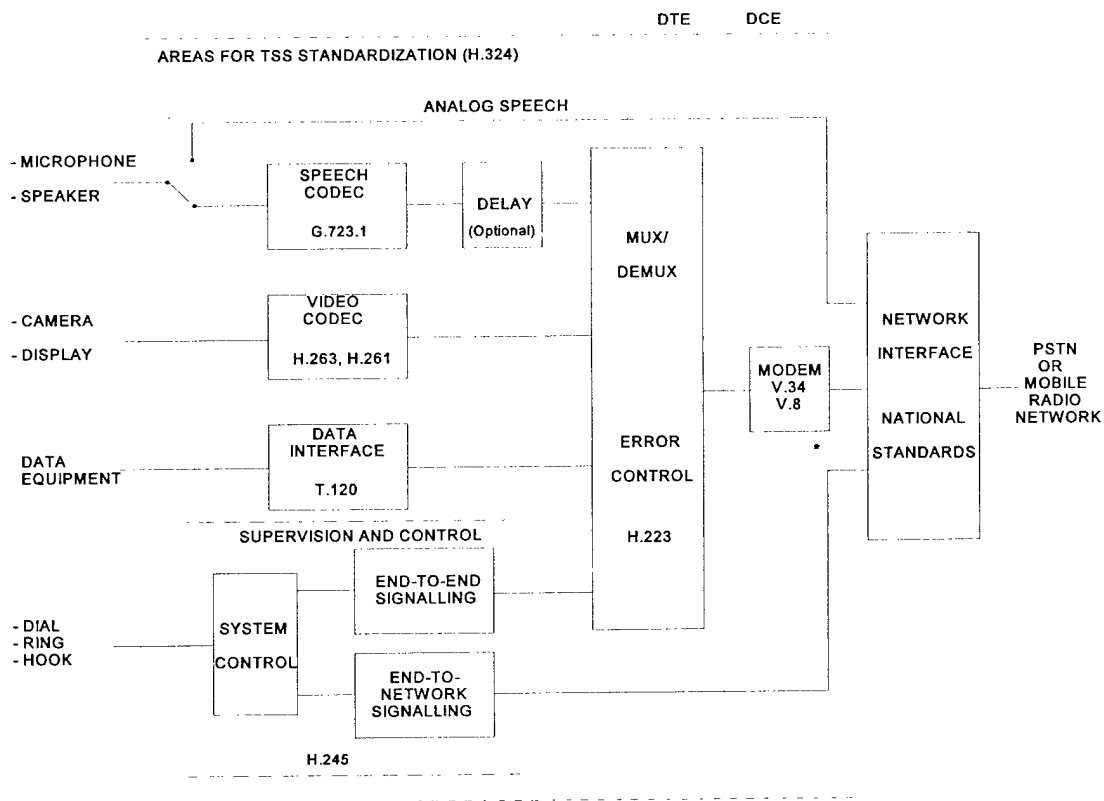
* Correct structure for PSTN videophone; may require slight modification for moble radio videophone.

Figure 3.1
Functional Block Diagram for Very Low Bitrate Videophone

3.1.2 G.723.1 (Speech Coder for Multimedia Telecommunications Transmitting at 5.3/6.3 kbit/s)

The G.723.1 Speech Coder can be used for a wide range of audio signals but is optimized to code speech. The system has two mandatory bit rates: 5.3 and 6.3 kbit/s. The coder is based on the general structure of the Multipulse-Maximum Likelihood Quantizer (MP-MLQ) speech coder. The MP-MLQ excitation will be used for the high-rate version of the coder. The Algebraic Codebook Excitation Linear Prediction (ACELP) excitation is used for the low-rate version. The coder provides a quality essentially equivalent to that of a POTS toll call. For clear speech, or with background speech, the 6.3 kbit/s mode provides speech quality equivalent to the 32 kbit/s G.726 coder. The 5.3 kbit/s mode performs better than the IS54 digital cellular standard. Performance of the coder has been demonstrated by extensive subjective testing. This coder encodes the audio signal in 30-msec. frames. In addition, there is a look ahead of 7.5 msec. Provision is provided to rapidly switch off the coder when speech is not present.

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3.1.3 H.263 (Video Coding at Rates Less than 64 KBIT/S)

It is mandatory that the H.324 terminal have available both H.261 and H.263 video coding algorithms. The picture format will adhere to the principles listed below and illustrated in the following table.

- decoding of both QCIF and sub-QCIF is mandatory;
- when sub-QCIF pictures are encoded with H.261, the transmitted format is QCIF (black borders); when sub-QCIF pictures are encoded with H.263, the transmitted format is sub-QCIF;
- the sub-QCIF picture format has the same pel aspect ratio as QCIF;
- in case of H.261, the number of significant lines and pels/line is up to the manufacturer; in case of H.263, the sub-QCIF picture format is 128x96;
- H.263 is mandatory for both the encoder and decoder of all GSTN-videophones, except an H.320 interworking adapter.

ALGORITHM	PICTURE FORMAT		FORMAT IN BITSTREAM	MANDATORY/ OPTIONAL
	ENCODER	DECODER		
H.261	QCIF or SQCIF*	QCIF	QCIF**	Mandatory
H.263	QCIF or SQCIF 128x96	QCIF and SQCIF 128x96	QCIF or SQCIF 128x96	Mandatory for Videophone-- Optional for IWA

* Any number of lines, pels/line less than QCIF. Pels must have same aspect ratio as QCIF.
** SQCIF pictures are transmitted with black borders.

The H.263 coding algorithm is an extension of H.261. H.263 describes, as H.261 does, a hybrid DPCM/DCT video coding method. Both standards use techniques such as DCT, motion compensation, variable length coding and scalar quantization, and both use the well-known macroblock structure. Differences between H.263 and H.261 are:

- Overlapped block motion compensation (optional)
- Motion vectors pointing outside the picture (optional)
- 8x8 pel motion vectors (optional)
- Syntax-based arithmetic coding (optional)
- H.263 has an optional GOB level
- H.263 uses different VLC tables at the Macroblock and block levels
- H.263 uses half pel motion compensation instead of full pel plus loopfilter
- in H.263, there is no still picture mode (JPEG is used for still pictures)
- in H.263, there is no error detection/correction included like the BCH in H.261
- H.263 uses a different form of macroblock addressing
- H.263 does not use the end of block marker

Of particular interest is the optional PB-frame mode. A PB-frame consists of two pictures being coded as one unit. The name PB comes from the name of picture types in MPEG where there are P-pictures and B-pictures. Thus a PB-frame consists of one P-picture which is predicted from the last decoded P-picture and one B-picture which is predicted both from the last decoded P-picture and the P-picture currently being decoded. This last picture is called a B-picture because parts of it may be bidirectionally predicted from the past and future P-pictures. The prediction process is illustrated in Figure 3.2. It is anticipated that the H.263 system will typically outperform H.261 (when adapted for the PSTN application) by 2.5 to 1.
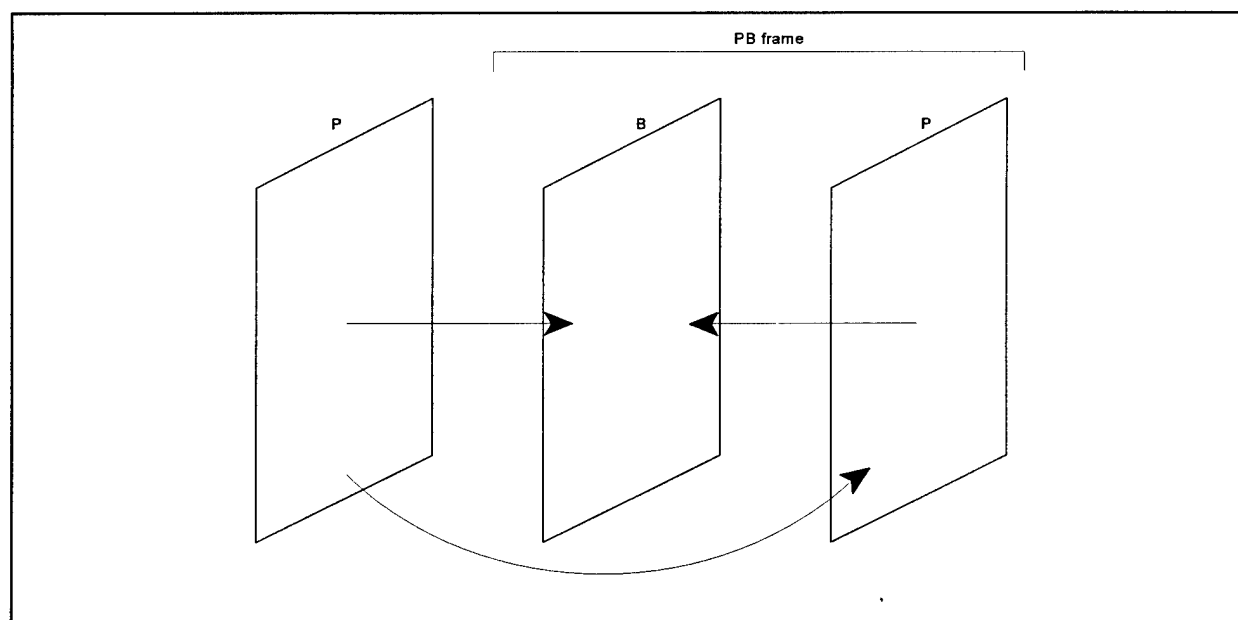
Figure 3.2 Prediction in PB-frames mode

3.1.4 H.245 (Control of Communications Between Multimedia Terminals)

The H.324 terminal allocates one virtual communication channel for the supervision and control of the operation of the terminal. Recommendation H.245 (Control of Communications between Multimedia Terminals) defines the communication protocol for the use of this channel. Examples of messages which are defined include (1) capability exchange, (2) mode-setting, (3) status indication, (4) call control, (5) encryption, (6) maintenance. Provision is made for both point-to-point and multipoint operation. Recommendation H.245 creates a flexible, extensible infrastructure for a wide range of multimedia applications including storage/ retrieval, messaging, and distribution services as well as the fundamental conversational use. The control structure is applicable to the situation where only data and speech are transmitted (without motion video) as well as the case where speech, video, and data are required.

3.1.5 H.223 (Multiplexing Protocol for Low Bitrate Multimedia Terminals)

Figure 3.3 is a functional block diagram of the H.223 Multiplexer illustrating a two-layer structure. The Adaptation Layer (AL) provides the interface between the individual virtual channels (video, speech, data, control) and the multiplex layer. The adaptation layer supports the underlying MUX layer and the next higher application layer. One of the most important functions performed by the AL is error control. In the case of video, the AL3 employs a retransmission strategy. The AL1 for the H.245 control channel is implemented using the V.42 LAPM protocol. Variable length packets are generated by the multiplex layer for transmission. This multiplex structure is particularly advantageous for adapting to the mobile radio environment which requires extraordinary error control procedures.
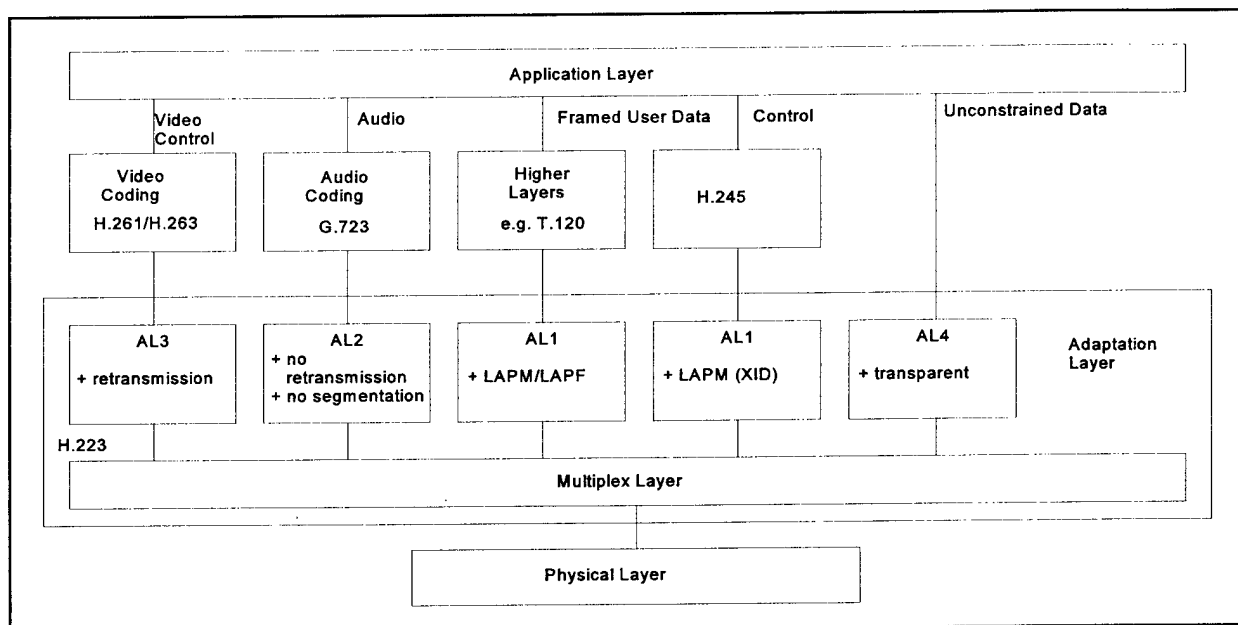
Figure 3.3 Protocol Structure of H.223

3.2   H.324M; Mobile Multimedia Terminal

The ITU-T has initiated a program to adapt the H.324 set of Recommendations [which define a multimedia terminal for PSTN operation] for transmission over mobile networks. The new mobile multimedia terminal is designated as H.324M.

Figure 3.4 illustrates the general structure of the H.324M mobile multimedia terminal which is clearly in the process of evolution and development. Work toward the H.324M Recommendation has been divided into the following areas of study; [1] speech error protection, [2] video error protection, [3] communications control [adjustments to H.245], [4] multiplex/error control of the multiplexed signal, [5] system. Items 1, 2, and 4 are the most complex areas requiring the most work, and

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considerable progress has been made as outlined in Table 3-1.
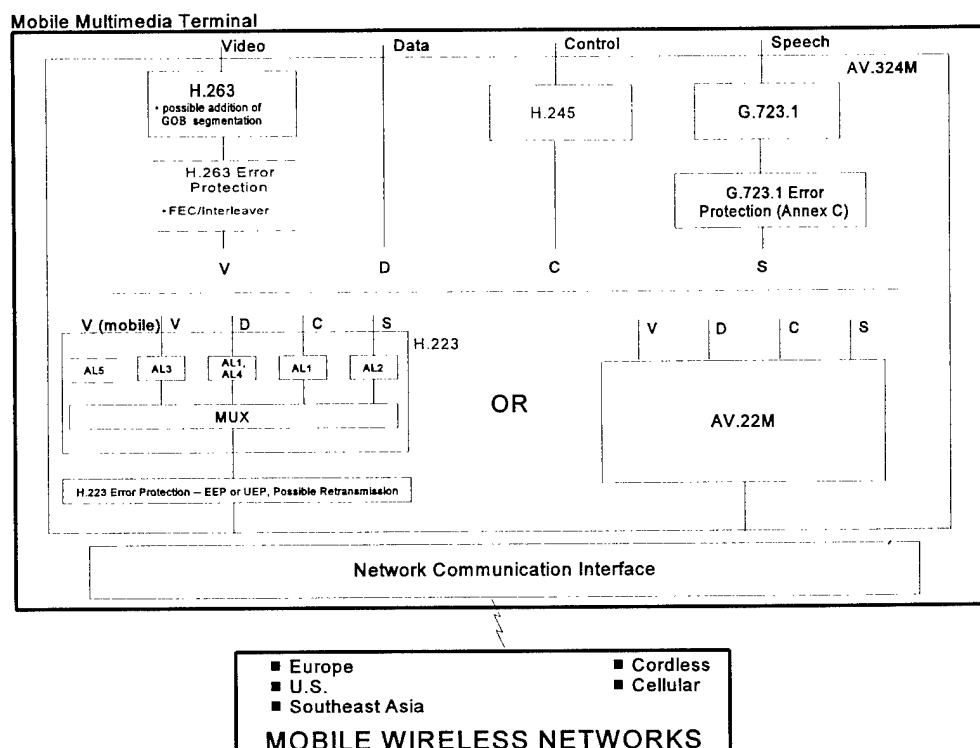
Figure 3.4 Mobile Multimedia Terminal

The general principles and underlying assumptions upon which the H.324M Recommendations are to be based are listed below.

1. H.324M Recommendations should be based upon H.324 as much as possible.

2. The technical requirements and objectives for H.324M are essentially the same as they are for H.324.

3. Since the vast majority of mobile terminal calls are with terminals in fixed networks, it is very important that H.32M Recommendations be developed which maximize interoperability with these fixed terminals.

4. It is assumed that the H.324M terminal has access to a transparent/ synchronous bit stream from the mobile network.

5. It is proposed to provide the manufacturer of mobile multimedia terminals with a number of optional error protection tools to address a wide range of mobile networks; regional and global, present and future, cordless and cellular. Consequently H.324M tools should be flexible, bitrate scaleable, and extensible

to the maximum degree possible.

6. Like H.324, non-conversational services are an important application for H.324M.

Table 3-1 H.324M Work Plan

H.324M FUNCTION	WORK PLAN	5/96 ACTION
Speech Error Protection	- Annex C of G.723; Successfully determined at 11/95 SG15 meeting; - "Scaleable Error Protection for G.723" - includes Unequal Error Protection (UEP)	Decision
Video Error Protection	- ARQ is valuable (inherent in H.223) - error concealment is very important (TCON) - UEP is temporarily rejected; error protection improvement may not justify added delay; further study - scaleable FEC/interleaving is possible addition - H.263 GOB segmentation is promising modification to H.263	Determination
Communication Control	Add code points to H.245	Determination
Multiplex	Compare two alternatives: 1. Add error protection to the H.223 bitstream; EEP or UEP; possible retransmission (would result in Annex to H.223). 2. A new multiplex structure (AV.22M); requires a new Recommendation specifically for mobile.	Determination
System	Annex to H.324	Determination

VIDEO - Considerable progress has been made toward the application of error control to the H.263 signal. Technology which appears particularly promising, includes ARQ, GOB segmentation, and error concealment. Work is also underway to determine the value of scaleable FEC/Interleaving for protection of video errors.

The application of Unequal Error Protection (UEP) to H.263 in a mobile environment has been studied extensively. A gain of approximately 2 dB in SNR can be obtained. The main disadvantage of the UEP is that the information of one frame must be stored for error protection processing. This causes one frame delay. UEP is temporily rejected since the disadvantages of the delay outweight this 2db improvement.

ARQ has been justified to be an important part of video error protection.

An error concealment alogorithm (TCON) that uses the H.263 unchanged, has been found to greatly improve the picture quality and is considered an absolute necessity.

Several core experiments with ARQ have been performed. The most advanced

proposal is to use sub-videos with re-transmission and intra refreshing. The GOB boundaries are treated as picture boundaries. This provides a considerable improvement in picture quality.

It has decided that error control for video may include a hybrid FEC/ARQ scheme. It is intended to provide a complete technical solution for video error control including ARQ, and potentially a flexible FEC/interleaver. The video error control will be flexible to be adapted to a range of mobile networks.

SPEECH - It was agreed to use the G.723.1 speech coder for the H.324 terminal, but it is also agreed that additional error protection is required for the mobile environment. At the November, 1995 meeting, the ITU-T selected a particular approach for protecting the G.723.1 signal and has designated it to be included as Annex C of the speech coder standard. Unequal error protection is employed by classifying the coded bits into 5 levels of error sensitivity.

A rate 1/3 convolutional channel code is used as the mother code for rate compatible punctured convolutional coding (RCPC). The system is automatically scaleable by bit rate so that the ideal error protection is applied regardless of the application bit rate (cellular, cordless or regional network, etc.).

MULTIPLEX- Two multiplex alternatives are being compared; [1] the addition of error protection to the H.223 bitstream, [2] a new multiplex approach based on a totally new system design.

COMMUNICATION CONTROL- Code points necessary for H.324M operation are being added to H.245 to provide for the necessary mobile operations.

SYSTEM- An Annex to H.324, defining the H.324M system, is being prepared which outlines the overall system structure of the mobile multimedia terminal.

3.3 T.120 - Graphic Communications For Multimedia Terminals

The ITU-T has developed, and continues to expand, the T.120 set of Recommendations which addresses a wide range of multimedia applications. Basically it provides the means to communicate the graphics segment [still pictures, computer graphics, white board, etc.] of a multimedia conference. The T.120 standard is specified in both the H.324 and H.324M multimedia terminal Recommendations as the optional way to transmit a wide range of graphics data in combination with the speech and/or video signals.

The T.120 series of Recommendations is composed of a communications infrastructure and application protocols that make use of it. Figure 3.5 shows the full model with both standardized and non-standardized components. The model serves both to show the scope of the T.120 suite of recommendations and the relationship

between each of the recommendations and other elements in the system. Generally, each layer provides services to the layer above and communicates to its peer(s) by sending Protocol Data Units (PDUs) via services provided by the layer below.

COMMUNICATIONS INFRASTRUCTURE

The communications infrastructure, illustrated in Figure 3.5 , provides simultaneous Multipoint connectivity with reliable data delivery. It can accommodate multiple independent applications concurrently using the same Multipoint environment. Connections can be any combination of circuit switched telecommunications networks and packet based LANs and data networks. It is composed of three standardized components: Generic Conference Control (GCC), the Multipoint Communications Service (MCS) and Transport Protocol Profiles for each of the supported networks. Adding GCC provides a range of facilities oriented to the use of MCS in an electronic meeting or conferencing but believed to be generally useful for other Multipoint communications requirements.
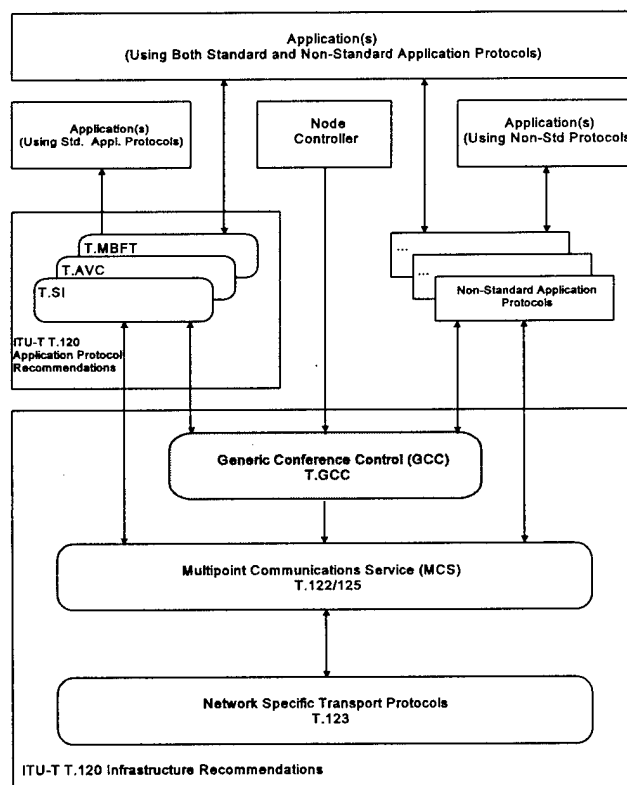
Figure 3.5 Scope of T.GCC

APPLICATION PROTOCOLS

Application protocols comprise a set of PDUs and associated actions for

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application peer-to-peer(s) communication. These may be proprietary protocols or they may be standardized by the ITU-T or other international or national standards bodies. The T.120 series includes a set of application protocols designed to support common facilities for graphic communication. These protocols define and mandate a minimum requirement in order to ensure interworking between different implementations, and include facilities for simultaneous file transfer (T.127) and audiographics protocols for still image viewing and annotation, application sharing and fax (all provided in T.126). See below.

Rec. T.126 - Still Image Exchange and Annotation (SI) - T.126 defines a protocol for viewing and annotating still images transmitted between two or more applications. This capability is often referred to as document conferencing or *shared whiteboarding.*

An important benefit of T.126 is that it readily shares visual information between applications that are running on dramatically different platforms. For example, a Windows-based desktop application could easily interoperate with a collaboration program running on a PowerMAC. Similarly, a group-oriented conferencing system, without a PC-style interface, could share data with multiple users running common PC desktop software.

Rec. T.127 - Multipoint Binary File Transfer Protocol - This Recommendation defines a protocol to support the interchange of binary files within an interactive conferencing or group working environment where the T.120 series of standards is in use. it provides mechanisms which facilitate distribution and retrieval of one or more files simultaneously.

3.4   Video Server/Database Access

One of the most important applications of the mobile multimedia terminal is the access of imagery [still pictures, video clips, computer graphics, etc.] from a remote database. Typical uses include remote diagnostics/maintenance/repair, sales presentations, workers on travel, access of drawings at a construction site, access of information in an emergency [fire, police, eathquake, terrorism, etc.].

The ITU-T and ISO are developing standards to address this requirement which is generally known as non-conversational services. The ISO has developed the DSM-CC [Digital Storage Media-Command/Control] standard which is part of the MPEG family of video coding standards. It is anticipated that this standard will be used in the future consumer set-top entertainment TV environment.

The previous Section 3.3 descibed the T.120 set of ITU-T Recommendations which may be used to access imagery from a remote database. Work continues to expand the T.120 Recommendations to provide for potential use to access remote data bases.

3.5 Advanced Video/speech Coding

ADVANCED VIDEO CODING

The recently developed H.263 video coding standard provides a signficiant improvement in picture quality for operation over very low bitrate networks such as the PSTN and the mobile environment. However, it is generally agreed that, for these very low bitrate applications, it is desirable to try to develop a more advanced coding algorithm which improves upon H.263. The ITU-T and ISO international standards organizations have both initiated long range programs [targeted completion date of 1998] to address this requirement. The ITU-T program addresses applications for both conversational and non-conversational services. Objectives include lower delay, higher compression, improved quality, robust operation in error-prone environments, and reduced complexity.

The ITU-T is working jointly with ISO/MPEG4 to develop advanced video coding technology having features beyond the normal frame-based "waveform" coding concepts such as DCT, fractals, vector quantization, wavelets, etc. Examples of these advanced features include [1] the establishment of foreground/background layers, [2] stereo coding, [3] object based coding [4] hybrid coding of natural and synthetic images, [5] coding of computer-originated video sequences based on three-dimensional models, [6] new video coding language to be possibly downloaded prior to transmission.

ADVANCED SPEECH CODING

The recently developed G.723.1 speech coding Recommendation provides a significant improvement in speech quality at very low transmission bitrates--5.3 Kbps and 6.3Kbps. The ITU-T has initiated a project to develop an even more advanced speech coder to provide toll quality at 4.0 Kbps. This coder, which is due for completion in 1998, will contribute greatly to the overall performance of the mobile multimedia terminal.

4 IMPLEMENTATION OF MOBILE MULTIMEDIA TERMINALS

The purpose of this section is to provide an overview of the status of the development of wireless multimedia terminals. The discussion is divided into the four parts listed below and presented in the following subsections.

MAVT PROJECT- For several years, the European Union has funded the RACE [Research in Advanced Communications in Europe] program, one part of which is directed toward the development of the MAVT [Mobile Audio-Visual Terminal]. Considerable resources have been allocated to this effort, and the work merits particular attention.

H.324 VIA AMPS- The mobile AMPS [Advanced Mobile Phone Service] network is a very large analog voice network which can be likened to the PSTN in function and operation. It is therefore reasonable to consider the direct application of the H.324 terminal [designed for the PSTN] for use on the mobile AMPS network.

PORTABLE GENERAL PURPOSE COMPUTERS- By far the most promising, and most immediate, version of wireless multimedia terminals will use portable general purpose computers. These devices have many inherent advantage; low cost, large high quality displays, high level of processing power, portability.

SPECIAL PURPOSE PRODUCTS- Some work has begun on the development of specific multimedia products for mobile networks.

4.1 Investigations in Europe

The objective of the European RACE/MAVT project is to develop video and audio coding algorithms for the transmission of moving and still video in a mobile environment. A brochure summarizing the MAVT program and its achievements is included in Appendix 4A. Major accomplishments of the MAVT program are listed below.

- 1992 to 1993: analysis of network characteristics; development of video and audio coding algorithms.

- 1994 to 1995: development of a demonstrator based on a desk-top PC with six special PC cards. The demonstrator provides bidirectional transmission of video and speech over a DECT [Digital European Cordless Telecommunication] network. The DECT bitrate is 32 Kbps, with the video occupying 24 Kbps and the speech 8 Kbps. Demonstrations have been successful proving the feasibility of multimedia via mobile networks.

-    1995: developed the design of a pocketsized multimedia terminal called "Handy".

4.2   H.324 Via AMPS

There are over 10 million subscribers to AMPS, and the network continues to grow rapidly. Since the network can be viewed as an analog PSTN network, it is reasonable to consider using the H.324 terminal directly on the AMPS network. One important advantage of this concept is the elimination of the interworking adapter at the interface between the cellular and PSTN networks which would be otherwise required to convert between the H.324 and H.324M signals. In this way a typical call from a user on a mobile network to a user on the PSTN could be readily accomplished with a minimum of distortion. A number of experiments, with both V.32bis and V.34 modems transmitting over the AMPS network, have been undertaken with very promising results.

To enhance the performance and reliability of cellular-modem communications, a number of modem manufactures have announced their support of MNP 10EC cellular modem technology. The MNP 10EC algorithm deals with cellular impairments such as cellular-bases-station handoffs, dropouts, interference, fading, and echoes to improve overall connectivity. The improvement is accomplished by packetizing the data stream using a V.42-like structure with the ability to rapidly change packet size based upon link conditions. The problem with this approach is that it is possible to add a large delay which can make interactive communications difficult. Work is underway by the modem community to modify the protocol to reduce this problem. Of course, the existing protocol is ideal for non-conversational access to data bases which is very important for mobile audiovisual applications. A press announcement deals with the MNP 10EC development is included in Appendix 4B.

Appendix 4C includes brochures on cellular modems which are configured for a PCMCIA interface to a notebook computer. This type of device permits existing laptop computers to be used for videoconferencing applications today. The notebook computer could communicate over the AMPS mobile network to a desktop personal computer containing the same type of cellular modem. Since many of the important elements of a teleconference system are available in all-software form it now feasible to field a notebook videoconferencing system communicating over the ubiquitous AMPS mobile network.

4.3   Portable General Purpose Computers

The advent of very high performance portable computers has made mobile wireless video teleconferencing systems practical today. A wide range of portable computers exists ranging from notebooks to tablets to palm-sized devices. The notebooks and tablets have ports for PCMCIA cards which have a wide range of functionality for mobile network applications. The processing power of these laptop and tablet computers has recently exploded. Pentium power is available on notebooks, and

Appendix 4D includes a brochure on a Fujitsu tablet powered by an Intel486 DX-50 microprocessor. In addition, the quality of the displays on these devices is radically improving. Finally the power of software-only implementations of video conferencing systems continues to improve. The simultaneous availability of all of these technologies makes mobile wireless VTC systems practical today.

The IBM ThinkPad series [Power series 850], described in Appendix 4E, is particularly interesting for mobile videoconferencing applications. An optional TV camera clips to the computer making it suitable as a source of VTC as well as a high quality display device. PCMCIA cards are also available to provide the interface between a video camera and a notebook computer. One example of such a device is included in Appendix 4F.

4.4   Special Purpose Products

Research has begun on the development of special purpose terminal devices for mobile videoconferencing applications.

For example, Matsushita/Panasonic has announced, and demonstrated, a new wireless VTC product which is illustrated in Figure 4.1. A press release describing the device in some detail is included in Appendix 4F. Features of the system are listed below.

-operates over 32kbps cordless transmission channel
-video coding using H.261 via ARQ retransmission capability
-2.5-inch color LCD screen
-speech coding by G.721
-QCIF resolution
-Frame rate - 3-7 frames/sec.

There is no question that the union of three of the most explosive technologies-- computers, mobile communication, video--will occur quickly, and the result will provide an extremely valuable facility for the federal government community.

At Comdex recently Matsushita Electric Industrial Co. showed prototypes of a cordless videophone system compatible with Japan's Personal Handyphone System (PHS). Long-range, Matsushita plans to incorporate the PHS videophone with notebook PCs and PDAs. The cordless videophone uses H.261 video and G.721 speech compression. Matsushita plans to work on the systemization of the technology within a private branch exchange (PBX).

Figure 4.1 Matsushita/Panasonic's Wireless VTC Product

5   APPLICATIONS OF MOBILE MULTIMEDIA TERMINALS

Wireless communications is a technology in which it seems the applications are limited only by the imagination. This statement may have been applied to other technologies previously but recent developments in the areas of wireless communications and personal communications have shown its validity particularly since it applies directly to the individual as well as to large organizations. For example, one aspect of wireless communication, Personal Communication System (PCS), is defined as the system by which every user can exchange information with anyone, at any time, in any place, through any type of device, using a single personal telecommunication number.

Of particular interest are the wireless applications involving imagery communication. Presently, for most applications of imagery communications, the terminal is a fairly large device which contains the communication interface, video processing and compression/decompression circuitry, image storage, and the display and operates over conventional common carrier channels. The development in the areas of wireless communications; such as cellular, terrestrial mobile, satellite, and cordless have provided freedom from the confines of hardwired communication channels. In addition, the high speed microprocessors and the portable and lap top computers in which they reside together with video application software has totally changed the concept of the imagery communications terminal. The terminal concept has also expanded to include mobile, portable, and even hand-held applications.

The following is a tabulation of some of the applications of wireless video terminals. The examples should be considered as generic and representative of a much larger field of applications.

1) TELECONFERENCING

Intra-complex teleconferencing without a hardwired LAN; The use of a wireless communication channel permits the terminal to relocate within an office complex without the need to rewire the cable plant. In fact, the terminal can roam from one application to another very efficiently. This technology can be implemented as a functional LAN and is often referred to as WLAN (Wireless LAN).

Intra/city teleconferencing without fixed cable plant; The same philosophy applies to relocation within a city. For example, city governmental functions can relocate, or roam as required in the performance of their function. This may be particularly suitable for emergency road crews, police, and fire protection. Legal requirements such as judge-suspect interviews, arraignments, etc., can be conducted very expeditiously without requiring either to be transported to a common location.

2) EMERGENCY/DISASTER SITUATIONS

Disaster recovery or any civil or natural emergency requires timely information transfer in both directions: site to headquarters and return. Video of the disaster area is needed by headquarters in order to properly allocate resources to the locations where they are most needed. Seldom are the proper communications circuits available; in fact, natural disasters generally decimate the lines of communication. Wireless radio systems have supported such communications for years. Now video systems utilizing wireless transmission can greatly enhance the flow of necessary pictorial information. The reverse path is just as critical. Headquarters can provide pictorial, map, graphic information, and computer data to the site, thereby greatly improving the quality and depth of information available to the personnel.

Situations as simple as traffic jams can be controlled more efficiently with the aid of wireless video. Pictures from the site of the congestion or the cause of the congestion can be transmitted to a central control point or to locations at which contributing traffic can be controlled to minimize additional congestion and to provide relief routes for the traffic.

This same approach applies to fire disasters. Pictures of the disaster and the action being taken for its control can be transmitted to a central control point. In addition, the pictures can generated at hazardous and otherwise inaccessible points to provide the most useful information

3) TELEMEDICINE

Medical records, in particular X-rays, are often stored in central locations, many in hardcopy form. They need to be accessed by doctors on a temporary basis. The use of wireless video transmission can greatly shorten the information transfer time and eliminate the effort required for the physical transport of such records to the doctor and their return to the central file .

Medical records are often needed in the field. A large medical service is provided by remote health workers in the field who travel to provide health services. They also need to access their patients's health records which may be stored at the host hospital. A wireless video link can provide this function. At an even higher level, these same health workers need to provide pictorial information including physical views of patient's injured areas and X-rays to the doctors at the host hospital in order to obtain their diagnosis.

4) LAW ENFORCEMENT

An application of wireless video transmission in the area of law enforcement (which has been experimentally implemented) is reading license plates at opportune locations. The video is transmitted by radio to a location where the data is compared to

a data base for various reasons. Since the system is not confined to a single location by hardwired communications circuits, it can relocated readily.

In many areas, police vehicles are equipped with radio facsimile devices to provide visual communications to the officer of records of vehicles or of persons apprehended, as well as general information from the central data base. In some cases a reverse service permits transmission of pictures, license, or registration data from the vehicle to headquarters.

5) PERSONAL/COMMERCIAL NAVIGATOR

Being lost while driving in an unfamiliar area or finding a road blocked and being required to take a strange road as a detour is a quite common occurrence. Techniques have been developed to provide a visual map type display to the vehicle via a wireless channel. Maps, of course, have limitations in that it may be difficult to quickly correlate them with the vehicle's surrounding while in motion. Pictures of key landmarks transmitted to the vehicle can be a great aid in becoming oriented and reaching the destination. Evaluation systems have been implemented but without the benefit of pictorial input.

An application which has been pursued with only moderate success to date using other techniques is transmission of video information about the movement of a mobile platform to that platform from a fixed environment. Docking a ship in a congested harbor can greatly be simplified by televising the progress of the ship through the congested area into the dock from the dock point of view and transmitting that sequence of motion images to the bridge of the ship. Shifter engine movement in a freight yard while assembling a train is a very similar application. In addition it can provide the engineer with the ability to verify the identification of a car by reading the ID label from the side of the car before attaching the next car. Tractor trailer truck drivers docking within the very tight confines of a typical docking area would benefit from images of their progress. Similarly, pilots of aircraft maneuvering to get to the loading ramp at a busy terminal would greatly benefit from seeing their relationship to other aircraft.

6) ENGINEERING/MAINTENANCE

Engineering data in addition to the normally available drawings may be required at a field construction, maintenance, or remote assembly area. Wireless video transmission of pictures, picture sequences, or computer based drawings can expedite problem resolution. Although drawings are often complex, ability to browse through a drawing (viewing a segment) can eliminate the need for extremely high resolution terminals and minimize transmission time. Other relevant image data includes parts list, exploded views, photographs, and even picture sequences of assembly, disassembly, and repair. Conversely, pictures transmitted via a return video wireless link can provide the image information to help headquarters personnel to solve field

problems.

7) ELECTRONIC NEWS GATHERING

The news media, both newspapers and television, are highly competitive to get the news to the public as quickly as possible. Several techniques are in use but provide only still pictures or moving pictures at comparatively great expense. Wireless video can be implemented in a small inexpensive unit to provide instant still and motion pictures at low cost to the media. The size/cost factor will permit many employees to be equipped with units. Even non-employees could transmit pictures to the media much as vocal news information is presently acquired by wireless telephone.

8) REAL ESTATE

Real estate agencies and multiple listing agencies can develop catalogs of motion picture information about their listings. Wireless video can be used by the agent to generate a walk through and walk around sequence of the property on the first visit and transmit it to the central office by wireless for incorporation into the catalog. Conversely, the agent at a potential customer's location, can access the central catalog and display motion sequences of selected properties to determine client interest.

9) REMOTE CONTROL

Many industrial applications can benefit from remote viewing and wireless transmission systems. Observation of a dangerous area or an area which has a difficult environment can be viewed by an observer in a safe, benign environment. When these situations arise there is often not enough time to procure the proper circuits for video transmission, and wireless systems are ideal. Difficult operations can benefit from wireless video displays. For example, loading supplies into the hold of a ship can be greatly facilitated if the loading control manager can personally view pictures of selected areas of the cargo hold to determine the amount of space available and its precise location and type of supplies stored there.

10) SURVEILLANCE

Casinos can benefit from wireless video transmission in that cameras can be located and quickly relocated to observe areas of particular interest. Trial systems have been successfully implemented.

In general, wireless video transmission is very applicable to surveillance applications. In many situations, an area needs to be observed only for a relatively short interval of time, e.g., a few hours or a few days. The camera and transmitting equipment must then be dismantled, stored, or relocated. Communications circuits are generally not available at these random locations and are expensive to implement. Furthermore, a substantial period of time would be required for their installation.

Neither of these conditions are tolerable for many surveillance applications making them ideal candidates for the use of wireless video. One example is repair of oil or gas pipeline damage. This damage generally creates an environment dangerous to repair workers and to residents of the area. By the use of wireless video, the progress can be observed by management personnel, experts in pipeline repair, and personnel responsible for flow through the pipeline.

Recently a wireless video unit (which does not incorporate any of the standards) has been put on the market to provide remote baby sitting. The camera views the sleeping child and transmit the picture to the parents or baby sitter who may be at a neighbor's house.

11) FACSIMILE

This is an area of wireless video communications which is already being exploited. One example of wireless facsimile as utilized by the police was described above. Personal facsimile capability has also been incorporated into wireless handheld devices (e.g., IBM's Simon) in addition to functioning as a multi-capability personal communication device. The application of facsimile utilizing these devices is extensive; e.g., salesmen obtaining sales material, field crews obtaining engineering data, etc.

12) COMPUTER VISUAL COMMUNICATION

Perhaps the greatest immediate concentration on wireless communication, which also utilizes video displays, is in the field of personal computer communications. These devices extend the computer to the field with the ability to access home office or other remote data bases. Several manufacturers have developed products which are being marketed. Other major corporations are developing products, forming alliances to combine capabilities (particular hardware and software) for this application.

These products fall into several categories: personal communicators, personal information processors, personal digital assistants, and personal intelligent communicators. In general they provide combinations of features from pen-based computers, cellular phones, electronic mail, speech and handwriting recognition, still image, full motion video, and video teleconferencing. Incidentally they may combine other features such as calculators, two-way pagers, calendars, appointment schedules, facsimile, and a full range of computer capability.

6   CONCLUSIONS AND RECOMMENDATIONS

The following conclusions are drawn from the work performed on this project.

- Wireless communications [cellular, cordless, wireless LANs, satellite] is undergoing a revolutionary change from analog to digital technology. This digital orientation will greatly facilitate the application of multimedia communications to the mobile environment.

- The ITU is developing a set of standards [H.324M] for a mobile multimedia terminal [to be completed in 1996] which will be applicable to a wide range of mobile networks. The advent of the H.324M standard will be key to the development of practical inexpensive wireless videoconferencing.

- Wireless multimedia terminals are practical today due to the advent of very high performance portable computers such as Pentium notebooks, tablets, and palm-sized devices, as well as software implementations of videoconferencing systems such as H.320 and H.324.

- The federal government will greatly benefit from the development of mobile multimedia terminals. Applications include teleconferencing, remote maintenance/diagnostics, disaster relief, and surveillance.

It is recommended that the following actions be undertaken to insure that the potential for mobile multimedia communications throughout the federal government community is fully realized.

- Support the domestic and international standards activities which are underway to develop Recommendations for wireless networks and mobile multimedia terminals [H.324M].

- Demonstrate the power of existing notebook computer technology and mobile networks to provide teleconferencing capability within the federal community today.

APPENDIX 4A

EUROPEAN UNION PROJECT - "MAVT"

Mobile multimedia by MAVT –
a starting point of many applications.
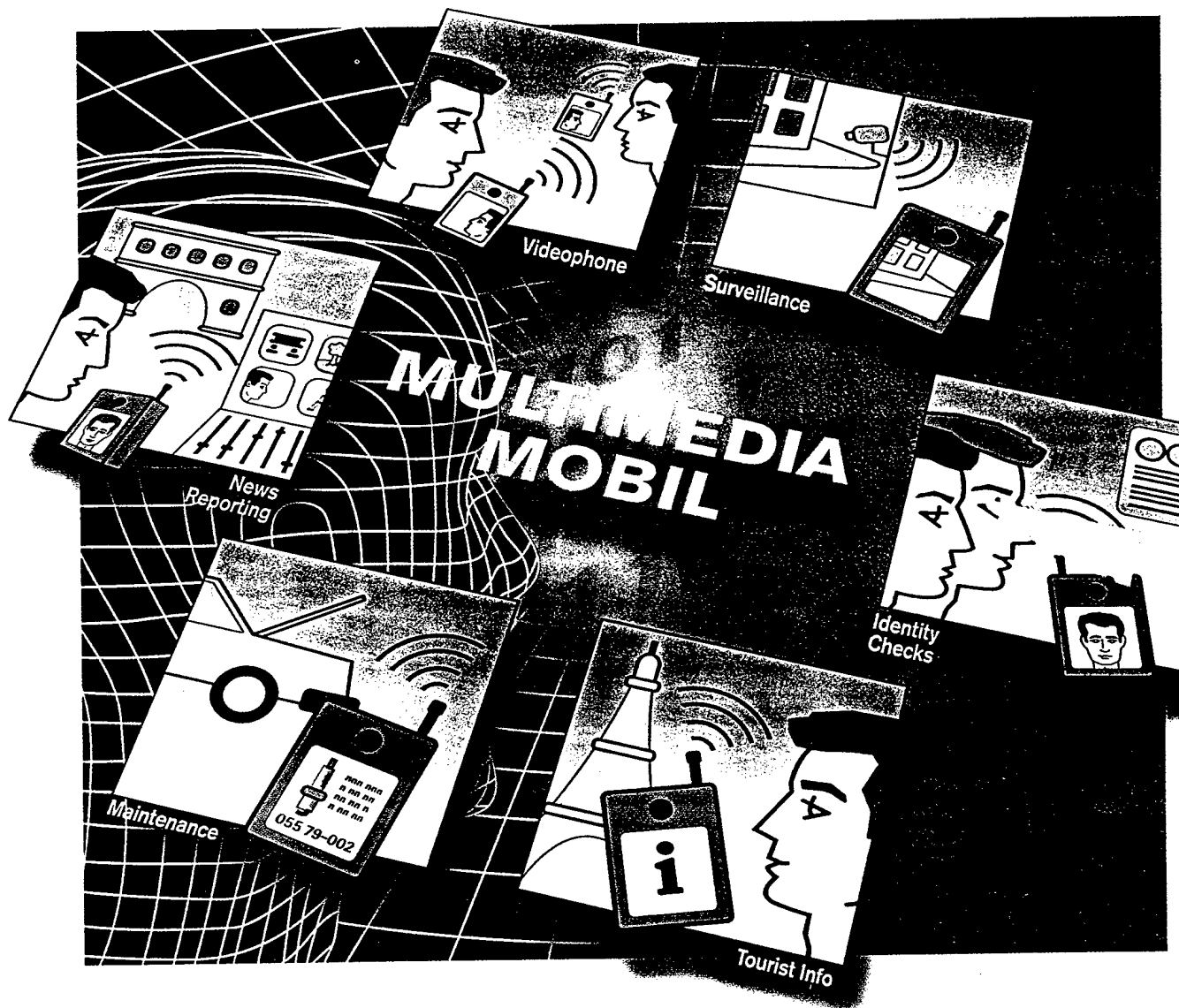
BOSCH

MAVT is forcing the development of mobile multimedia.

The main objective of the MAVT project is the unification of the mobile telecommunications world with the multimedia computing world, two fields with high market expectations. With the developed demonstrator, the project has proven the feasibility and performance of mobile multimedia communications. The demonstrator represents the basis for the evolution of mobile multimedia terminal equipment.

Recent digital signal processor developments allow a further integration and reduction of the terminal to the size of a portable PC or notebook. The MAVT project is conducting this next evolution step. In addition, the transmission of data, besides audio and moving video, will be possible.

The developed coding techniques have been submitted to corresponding standardization bodies, which guarantees a broad market introduction of mobile multimedia terminals. Access to second generation networks such as DECT, GSM, and TETRA is accomplished through corresponding PCMCIA adapters.

The MAVT consortium is further engaged in standardization activities within ISO MPEG-4 and ETSI SMG5, with the purpose of introducing new algorithms and services for multimedia applications in future mobile networks of the third Generation such as UMTS (Universal Mobile Telecommunications System) and IMT-2000 (former FPLMTS).

Design studies and prototypes developed within the project give an impression of the future communications world.

Coding Methods for Narrowband Channels

The compression of speech is accomplished through a uniform pulse code exited linear prediction scheme (RPCELP). An implemented efficient echo cancelation allows further the application of a hands-free processing unit.
Video coding is based on a block-oriented, hybrid scheme with QCIF (176 x 144 pels) spatial resolution and a temporal resolution of 5 Hz (frame rate). The source coded information is protected against transmission errors with a selective channel coding scheme according to their sensitivity. This combined source-channel is accomplished through application of Rate Compatible Punctured Convolutional (RCPC) codes.
An additional convolutional interleaver is applied for spreading the burst errors encountered in a mobile environment. The channel is shared between speech and video, whereby error protection and interleaving is accomplished with respect to the individual information streams.

MAVT Demonstrator

The demonstrator is based on a desktop PC with additional six PC cards, which contain the video codec, audio codec, multiplexer and network interface. Commercial available digital signal processors are applied for the realisation of the individual hardware components. A graphical user interface tailored to audiovisual telephony applications allows a comfortable operation of the audiovisual terminal.

Transmission of moving Video and associated Audio over DECT

The MAVT demonstrator allows a transparent, bidirectional transmission of video and associated speech over a DECT (Digital European Cordless Telecommunication) network, i.e. a cordless, digital telephone environment. Access to the network is accomplished with modified commercial available terminal equipment (handy) with a gross data rate of 32 kbit/s, which is shared between video (24 kbit/s) and audio (8 kbit/s).

UMTS Field Trials

The transmission of video and audio over third generation mobile networks will be demonstrated and evaluated in the context of corresponding field trials. For this purpose, the MAVT demonstrator will be connected to the UMTS network demonstrators developed within the RACE II projects ATDMA (Advanced Time Division Multiple Access) and CODIT (Code Division Testbed).

UMTS

Begin of 1995
Transmission of moving video and
associated speech over DECT

End of 1994
MAVT Demonstrator

1993-94
Development of coding schemes for
narrowband channels

1992
Analysis of network
characteristics and user requirements

Standard for low bit rate Videotelephony

Simulation results and results obtained with the real time demonstrator with respect to the "short term" coding algorithms are being considered within the standardization activities in ITU-T SG15. This body aims at a definition of a standard (H.324) for low bit rate videotelephony until the end of the year 1995. Corresponding adaptations of the underlying coding schemes for mobile applications (AV.32M) have been proposed and are coordinated by members of the MAVT project.

ISO MPEG-4

Long term, region oriented coding schemes will provide, besides higher compression ratios, enhanced video quality and the possibility of object manipulation. New functionalities will allow processing of image contents and therefore a significant extension of the range of applications of multimedia terminals. A system independent syntax description language is being developed, which allows a flexible, online configuration of future terminal equipment. The MAVT represents the European platform for corresponding standardization activities within ISO MPEG-4.

UMTS

The third generation telecommunications system UMTS will provide data rates between 8 kbit/s and 2 Mbit/s, and will allow the provision of a broad range of services with a quality known from wired networks. MAVT is engaged in the specification of services for the future UMTS within ETSI (European Telecommunications Standard Institute).

Mobile Multimedia Handy

It can be foreseen, that by the year 2000 a pocketsize multimedia terminal through high integration of individual components will be reality. This will allow multimedia communications at every geographical location at any time. The MAVT 2000 includes, besides a functional design, a comfortable graphical user interface adapted to the needs of individual user groups.

2000
Mobile multimedia handy

1999
UMTS standard for third generation
mobile networks and services

1998
MPEG-4 standard with full
multimedia functionalities
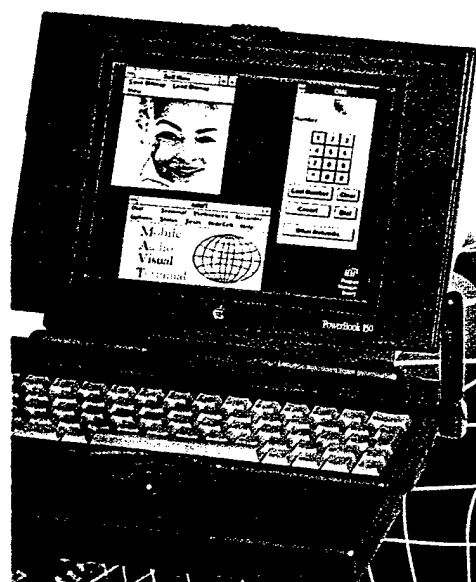
End of 1996
Transmission of video, audio and data in
second generation mobile networks

1995-96
Portable multimedia terminal

End of 1995
ITU-T standard for low bit rate
video telephony

1995
field trials

The RACE II project MAVT.

The MAVT project is part of the RACE II (Research and Technology Development in Advanced Communications Technologies in Europe) programme funded by the European Union. The consortium consists of eighteen partners belonging to well known industrial companies, network operators and universities, whereby the Robert Bosch GmbH, Hildesheim, assumes the position of the project coordinator.

The project seeks to develop robust coding algorithms for low bit rate transmission of multimedia (video, audio, data) over second and third generation mobile networks. In the project context, the algorithms will be implemented on a demonstrator for demonstration of audiovisual applications in real time. Furthermore, the MAVT project is actively engaged in corresponding standardisation activities within ISO MPEG-4, ETSI SMG5 and ITU-T SG15.

Consortium:

Robert-Bosch GmbH	D
Siemens AG	D
Matra Communication	F
Telefonica de Espana	E
Instituto Superior Tecnico	P
PTT Nederlande	NL
Queen Mary & Westfield College	UK
ITIS (Innovation Telecommunications Image Son)	F
Thomson LER	F
CSELT (Centro Studi e Laboratori I Telecommunicazioni)	I
Universität Politecnica de Catalunya	E
Ecole Polytechnique Federale Lausanne	CH
Philips LEP	F
Daimler-Benz AG	D
Center Morphological Mathematics	F
CCETT (Centre Commun d'Etudes de Telecommunications et de Telediffusion)	F
France Telecom CNET	F
Bosch ANT Nachrichtentechnik	D

BOSCH

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APPENDIX 4B

MNP 10EC CELLULAR MODEM
PRESS RELEASE

SUBJECT: MORE THAN 100 COMPANIES RALLY TO DEPLOY CELLULAR MODEMS
     WITH MNP 10EC -- ROCKWELL SHIPS MNP 10EC PRODUCTS
     ENSURING MAXIMUM RELIABILITYFOR COMPUTER COMMUNICATIONS
     OVER CELLULAR NETWORKS
SOURCE: Business Wire via First! by INDIVIDUAL, Inc.
DATE: April 17, 1995
INDEX: [8]

   NEWPORT BEACH, Calif.--(BUSINESS WIRE) via First! -- Rockwell
Telecommunications and other leading communications companies
representing modem, personal computer, cellular phone, network
access equipment, cellular carrier and online services industries
Monday announced their support of MNP 10EC cellular modem
technology.

   This technology launch is a broad industry effort to enhance
performance and reliability for cellular-modem communications.
Cellular phone users can now have reliable connectivity for remote
access to desktop computers, fax machines, electronic mail and
online services, including the Internet and bulletin boards.

   "This group of stakeholders shares a common goal for the
industry. We wanted to provide cellular data users the ability to
stay connected over varied cellular conditions, at the lowest
billable air time," said Armando Geday, business director,
Rockwell Modem Systems. "We joined forces to conduct extensive
testing and deliver MNP 10EC as a total system solution, assuring
maximum reliability in cellular modem applications."

   Rockwell is now shipping V.32bis and V.34 modem chipsets with
MNP 10EC. Announced in November 1994, MNP 10EC incorporates
signal conditioning technology implemented in the digital signal
processor (DSP) and enhancements to the existing MNP 10 adverse-
channel protocol. The DSP implements cellular specific
algorithms to deal with impairments such as cellular-base-station
handoffs, dropouts, interference, fading, echoes, audio
distortion for improved connectivity. The enhancements to the
MNP 10 protocol optimize the data throughput for varied channel
conditions.

   "The next generation of MNP 10 modem technology enhances
cellular connectivity and performance through a systems approach
where modem protocol and data pump enhancements work together to
overcome the problems inherent in the cellular environment," said

Gregory Pearson, senior vice-president, technology management, Microcom.

   Rockwell's Direct Cellular Access technology gives users the ability to connect a modem directly to a cellular phone and is a standard feature in Rockwell's V.32bis and V.34 low-power product families. Other features include headset support, telephone emulation, automated digital answering machine, message forwarding, automated voice response, business audio, remote fax access, speakerphone, and Voice View alternating voice-and-data capabilities.

   o Apex Data -- "In Apex Data's quest to constantly improve its product quality and performance, Apex has committed to implementing the new Rockwell MNP 10EC chipset into all future modem products," said Ross Forman, vice president of research and development for Apex Data. "As a leader in wireless modem technology and with the proliferation of cellular phones, this will help to insure the most consistent and reliable connection for our customers."

   o Ascend Communications, Inc. -- "The addition of reliable cellular access via MNP 10EC significantly enhances our MAX WAN access switch product line so that mobile cellular-based users can reliably access their corporate LANs and the Internet," said Robert Ryan, chairman and CEO, Ascend Communications Inc. "Ascend, which has set the industry standard for remote access switching among Internet service providers, feels certain that featuring MNP 10EC technology in our MAX products will help us lengthen our competitive lead in the WAN access equipment market."

   o Bell Atlantic Mobile -- "We are pleased to see Rockwell and other industry leaders' commitment to cellular data transmission. Our initial tests with MNP 10EC show significant improvements over MNP 10. We look forward to further evaluating modems at the production level. Commercial availability of this new technology should add even greater value to our customer's investment in cellular communications," said Michael D. Franklin, Bell Atlantic Mobile's director, product management for wireless data.

   o CompuServe -- "CompuServe is encouraged by the broad support of MNP 10EC," said Janel Crabtree, product manager of network marketing and wireless access, CompuServe. "We are currently working with Rockwell in evaluating MNP 10EC to support wireless

access to our networks for our customers."

o Current Logic -- "Current Logic (formerly Macronix) has been
developing cellular remote and host-side hardware for several
years. We have selected MNP 10EC to be at the core of our
portable and host-side platform. We find that MNP 10EC provides
the reliability we can ship with confidence to our customers,"
said Kevin Asay, vice president of sales and marketing, Current
Logic.

o Megahertz -- "Megahertz has continually sought to increase
the performance of its notebook connectivity products, including
the cellular capable modem," said Steve Smith, senior vice
president of marketing for Megahertz Corp., a subsidiary of U.S.
Robotics. "In assisting Rockwell with its implementation of MNP
10EC, we feel we have created a solution that will greatly
enhance the users' experience and ability to transmit data over a
cellular connection."

o Mitsubishi -- "Mitsubishi is impressed with the performance
of MNP 10EC modems," said Ed Murphy, Mitsubishi International's
sales manager for Data Products. "We are continuously studying
new technologies and developing new products for the wireless
data market. We look forward to working with MNP 10EC modem
suppliers to ensure optimal performance and greater compatibility
of modems and Mitsubishi cellular telephones."

o NEC Technologies, Inc. -- "NEC Technologies is committed to
offering computer solutions to our customers," said Marty
Zartarian, senior product manager for personal computer systems
at NEC Technologies. "We support MNP 10EC technology because it
will expand the use of computers in communications."

o Primary Access -- "Primary Access is the market leader in
providing modem pool equipment used by more than 20 cellular
carriers and internationally by carriers in Argentina, Canada,
Korea and Venezuela," said Andy May, vice president of marketing
for Primary Access. "MNP 10EC provides significant performance
improvements over the current MNP 10 implementation. As the
leading provider to cellular carriers, Primary Access is committed
to supporting every significant modem technology. We look forward
to introducing MNP 10EC's higher levels of cellular data
performance in our future products."

o Smart Modular Technologies -- "We are confident that MNP 10EC

modems will satisfy the demanding connectivity needs of the
consumer," said Ajay Shah, president, Smart Modular Technologies
Inc. "The initial testing of our MNP 10EC modems show superior
performance over other cellular modem technologies."

o Simple Technology -- "Our PCMCIA products emphasize the value
of feature integration to the customer for different connectivity
requirements," said Mark Moshayedi, president of Simple
Technology. "MNP 10EC provides the cornerstone to extending our
connectivity features to the wireless market."

o Supra Corp. -- "Supra modems address the large installed base
of BBS-fixed server location and desktop modem markets," said Jim
Cady, vice president, sales and marketing, Supra Corp. "And we
are committed to deploying MNP 10EC across our line products to
provide maximum cellular performance."

o TDK Systems -- "We are dedicated to providing quality PCMCIA
solutions. The new MNP 10EC cellular technology achieves the
levels of high performance and reliability that TDK's customers
have come to expect," said John Huggins, general manager and vice
president, TDK Systems.

o Toshiba Information Systems Inc. -- "Toshiba's Noteworthy
line of PCMCIA fax-modem products is synonymous with reliability
for cellular connectivity," said Wiley J. Ehrke, director,
communications and accessories marketing, Computer Systems
Division, Toshiba Information Systems Inc. "Offering MNP 10EC
technology in our products will further enhance the level of
connectivity for our customers, enabling them to address a
broader range of applications."

o Telecomm Italia -- "We are very interested in MNP 10EC
technology," said Robert Vannini, director Telecomm Italia,
Divisione Mobile. "We are actively evaluating it and we think
that, once deployed, such technology could allow us to offer a
very good data communication service over Telecomm Italia's
Analog Cellular Network."

o Zoom Telephonics -- "Zoom is a leader in providing desktop
modem solutions that support the communication needs of the mobile
user. The introduction of MNP 10EC into both our desktop and
cellular direct connect PCMCIA modems represents the first solid
bridge between desktop computing and mobile communication," said
Frank Manning, Zoom president and CEO.

Rockwell Telecommunications is comprised of three principal businesses: the Digital Communications Division (DCD), the Microelectronics Technology Center (MTC) and the Switching Systems Division (SSD). DCD, based in Newport Beach, Calif., is the market leader in fax and data modem components, with an installed base of more than 75 million modems worldwide.

Rockwell (NYSE:ROK) is a diversified, high-technology company holding leadership market positions in automation, avionics, aerospace, defense electronics, telecommunications, automotive components and graphic systems, with annual worldwide sales of more than $12 billion. NOTE TO EDITORS: MNP is a registered trademark of Microcom Inc.

Industry supporters of MNP 10EC include: Aceex Corp. Acer Peripherals Inc. Action Tec Electronics Ascend Communications Airtech Communications Amquest Anstar International Ltd. Apex Data Archteck Telecommunications Corp. Askey Computer Corp. Aspen Technologies Inc. Atrie Technology Inc. Best Data Products B&V Banksia Technology Pty. Ltd. Bell Atlantic Mobile Boca Research Cardinal Technologies Inc. Charter Pacific Communications CIM Systems Ltd. Circuit Research Corp. CIS Tech. Inc. Computer Peripherals Inc. Comcor Technology CompuServe Compuspec Industries Comtec System Co. Ltd. Cosmos Technology CPV Stollman Crypto Crystalake Multimedia Current Logic Systems Inc. Dataplex Pty. Ltd. Digicom Digital Logic Inc. E-Tech Inc. EXP EyP Gamma Garnet Systems Co. Ltd. GVC Hanwha Communications Co. Ltd. Hinetek Hotline Export Insys Intellicard Systems Interlink Electronics Intertex Lasat Communications Lectron Co. Ltd. LG Electronics Co. Ltd. Logicode Lung Hwa Electronics Maestro Digital Communications Mac System Martignoni Maytech International Corp. Mediacom Megahertz, a U.S. Robotics subsidiary Mike Boorne Electronics Pty. Ltd. Microcom Inc. Mitsubishi International MNC Intl. Inc. Naewae Semiconductor Inc. NEC Technologies Inc. NetComm Ltd. New Media Northrop Grumman Novalink Ositech Pace Micro Communications Pacific Research Piiceon Pora Corp. Primary Access Corp. Primax Electronics Ltd. Psion Dacom Quantum Data Systems Ltd. Samhee Electronics Co. Ltd. Saruman Communications Samsung Electronics Co. Ltd. Satelivision SMC Shiva Corp. Simple Technology Sinolog Co. Ltd. Smart Modular Sundex Electronics Ltd. Supra Corp. Taeil Median Co. Ltd. Taicom Data Systems Co. Ltd. TDK Systems Telecomm Italia Telejet Telelink Teleware Telital The Networking Co. Three J Tech Co. Ltd. Toshiba America Information Systems Trigem Computer Inc. Unique Hardware Co. Ltd. Ventel VTech Computers Ltd. Well Communication Co. Welltronix C. Ltd. Zoltrix Zoom Telephonics

CONTACT: Rockwell Telecommunications, Newport Beach | Julie
Seymour, 714/833-4379 | or | Eileen Algaze, 714/833-6849

[04-17-95 at 17:24 EDT, Business Wire, File: b0417172.400]

APPENDIX 4C

CELLULAR MODEM PRODUCTS

ᐱ Rockwell

Rockwell's portable modem chipset solutions now offer communications capabilities over the circuit-switched cellular network, providing an instant solution to the mobile market's increasing need for "anytime, anywhere communications."

Cellular Connectivity with Rockwell Modems

Anytime, Anywhere Connectivity

The widespread coverage of the analog cellular network service throughout the world provides support for mobile data communications. This infrastructure will support the explosive mobile communications needs of the 1990s enabled by Rockwell's high-performance modem engines.

Mobile communications via this infrastructure will take full advantage of existing communications application software, eliminating the need for new applications software. Mobile users will communicate over the cellular network with their existing fax and data software applications and have the ability to access or provide information wherever their cellular phones are serviced by the network.

Cellular Activatable Chipsets

Rockwell's portfolio of portable high-speed modem chipsets, from V.32 to V.34, now incorporate MNP 10EC™ providing these modems with data communications capabilities over the analog circuit-switched cellular network.

These modem device sets now enable designers to combine wireless and wireline connectivity for both the mobile and desktop communications markets. Specifically packaged in small low profile form-factors and featuring low power consumption, these devices are ideally suited for notebook, palmtop, PDA and PCMCIA applications.

ᐱ Rockwell

Robust Communications

Enhancements have been made by Rockwell and Microcom to the ubiquitous, adverse-channel Microcom Networking Protocol™ Class 10 (MNP® 10) to optimize modem performance over circuit-switched cellular networks. The result is MNP 10EC, a total system solution which incorporates complementary enhancements to the existing MNP-10 protocol combined with Rockwell's new Cellular Optimized Processor™ (COP) data pumps.

This protocol monitors the channel consistently, adjusting the communications parameters to take full advantage of the cellular channel characteristics during a communications session and optimizing the performance of data communications over the cellular link.

Rockwell's COP technology is designed to overcome the hindrances of the analog cellular network. The COP modem data pump recognizes common cellular-network impairments — frequent cellular base-station handoffs, dropouts, call interference, fading, echo and other types of signal distortions — and quickly recovers the signal. The new COP technology will provide significant performance improvements when connected to a standard landline modem and dramatic improvements when it appears on both ends of the connection.

Downloadable Phone Drivers

Each cellular phone features its own specific connector and programming model. Rockwell's activatable chipsets have the capability to support installed and new phones merely with the download of the specific "phone personality driver." This architecture enables end users to readily switch or upgrade cellular phones with a Rockwell cellular modem solution.

	RC288ACL * Cellular Optimized Processor – RC288DPL	**RC144ACL** * Cellular Optimized Processor – RC144DPL
CCITT Data Standards	• V.34,V.FC (28.8Kbps, 24.0Kbps, 19.2Kbps), V.32bis, V.32, V.22bis, V.22, V.23, V.21, V.26bis, V.26AltA, Bell 212A and 103	• V.32bis, V.32, V.22bis, V.22A/B, V.23, V.21, Bell 212A and 103
Group 3 Fax Send/Receive	• V.17, V.29, V.27ter, and V.21 Channel 2	• V.17, V.29, V.27ter, and V.21 Channel 2
Voice Modes (Optional)	• Voice Pass-Through Enhanced ADPCM	• Voice Pass-Through Enhanced ADPCM
Error Correction	• V.42 LAPM and MNP 2-4	• V.42 LAPM and MNP 2-4
Data Compression	• V.42bis and MNP 5	• V.42bis and MNP 5
Adverse Channel Protocol	• MNP 10EC	• MNP 10EC
Packaging	• 68PLCC + 80PQFP or 100PQFP + 80PQFP + 80PQFP	• 68PLCC + 80PQFP or 100PQFP + 80PQFP + 80PQFP
Power Consumption		
Active	• 790mW (Typ)	• 540mW (Typ)
Standby	• 20mW (Typ)	• 21mW (Typ)
Stop	• 9.8mW (Typ)	• 10.8mW (Typ)
Power Requirements	• +5VDC	• +5VDC

The Rockwell Modem 10-Point Advantage

1. *35 Years of Leading Modem Technology*
2. *75 Million-Unit Installed Base*
3. *Lowest Total System Cost*
4. *Complete Voice/Data/Fax Solutions*
5. *Optimized Processor and Algorithm Capabilities*
6. *Advanced Manufacturing and Packaging Technologies*
7. *Worldwide Technical Support*
8. *Complete Product Documentation*
9. *Highest Quality/Reliability*
10. *Standards Leader*

Rockwell Telecommunications

MOTOROLA CELLect PCMCIA FAXMODEM

- Full-featured V.32bis/V.42bis PCMCIA Type II modem

- 14.4Kbps operation with 57.6Kbps throughput

- Cellular or wireline connections

- Data or Fax transmission

- High-speed, compact, lightweight

- Direct connection to data-capable Motorola MC2™ MicroTAC™ cellular phones

- Fully V.32bis compliant

- Motorola quality and reliability

The Go-Anywhere Modem

The Motorola CELLect PCMCIA Modem is perfect for the business person on the move. Its credit-card-like size means you can travel light while sending or receiving data or faxes at anytime, from virtually anywhere cellular service is available. Designed for use with data-capable Motorola MC2 MicroTAC cellular phones, the modem permits direct connection to many PCMCIA compatible laptop, notebook or palmtop personal computers. Internal DAA is provided for easy access to standard PSTN (Public Switched Telephone Network) phone lines. And there are no bulky external interface units or DAA pigtails to load you down.

Fortunately, you do not have to sacrifice performance for portability with the CELLect PCMCIA Modem. It is a high-speed V.32bis compliant modem with all the features you would expect from an advanced design. It operates at up to 14.4Kbps, has V.42bis error correction and a throughput rate of 57.6Kbps thanks to four-to-one data compression. Low power consumption and an innovative power standby mode help extend computer battery life. In fact, the modem can be left in the computer even when not in use.

The CELLect PCMCIA Modem is specifically designed to deal with data transfer problems unique to cellular systems, such as, hand-offs and noise distortion. Although throughput rates vary depending on cellular conditions, the CELLect Modem operates at up to 9600bps before four-to-one compression. Motorola's Enhanced Cellular Control™ (EC2) improves data reliability while remaining compatible with the installed base of industry standard V.32bis modems. Unlike proprietary enhancement methods, EC2 modems are not required at the land end, enabling you to take advantage of CELLect's capabilities without the immediate change-out of existing network equipment.

As a Fax Modem

The PCMCIA CELLect Modem is fully CCITT Group III compatible enabling you to communicate with any other Group III fax device anywhere in the world. It also conforms to the EIA-578 standard, and, when used with an EIA Class 1 software package, can send and receive faxes at 14400, 12000, 9600, 7200, 4800 or 2400 bps. The fax software runs in the background, allowing you to go on working while the modem automatically accepts incoming faxes and transmits outgoing documents according to your pre-programmed schedule. T.30 Error Correction Mode is incorporated to help ensure error-free transmissions.

As a Data Modem

The CELLect PCMCIA Modem is a full-featured V.32bis/V.42bis modem that is capable of accurately throughputting large files at speeds up to 57,600 bps. Operating full-duplex on the dial-up network, it runs asynchronously at 300, 1200, 2400, 4800, 7200, 9600, 12000 or 14400 bps and automatically matches its speed and modulation scheme to the originating modem. CCITT V.42 and MNP level 4 error control are provided to help ensure error-free communication with similarly equipped modems.

Features & Benefits

Compact size — Small, lightweight modem and cabling are easy to pack and carry.

Wireless and wireline — Can be used almost anywhere with direct connection to cellular or PSTN.

PCMCIA Release 2.01 Type II compliant — Interoperable across multivendor platforms.

Internal DAA — Eliminates bulky external pigtail DAA.

Low power consumption — 150 mA power requirement and unique standby feature extend computer battery life.

Fax Mode

High-speed facsimile machine — Sends and receives faxes at up to 14.4Kbps to and from any PCMCIA compatible computer and any Group III fax machine or modem. Eliminates the need for a separate fax machine.

Standard Class 1 interface -- Non-proprietary interface conforms to EIA-578 and is compatible with all standard Class 1 fax software packages.

Fully CCITT Group III compatible — Communicates with Group III compatible fax devices anywhere in the world.

Supports CCITT Binary File Transfer — Complies with CCITT V.21 Channel 2, V.27ter, V.29.

Supports HDLC framing at all speeds — T.30 Error Correction mode increases accuracy and reliability.

Data Mode

Compliance with CCITT and Bell standards — Compliance with CCITT V.32bis, CCITT V.22bis, and Bell 103J standards at a variety of speeds lets you communicate with a large installed base of modems.

Rate adaption — The modem adjusts its data rates as line quality changes to minimize errors and maximize throughput. Reduces retrains and the need for retransmissions resulting in lower line costs.

V.13 compliance -- Allows switched carrier simulation/remote carrier control. Increases compatibility with DTEs that require switched carrier.

Remote configuration — Permits option settings of a remote unattended modem to be changed over the phone line. Allows network managers to configure unattended remote network modems upon initial installation without involving the users. Password security protects against unauthorized use.

V.42bis protocol CCITT standard for asynchronous error correction/data compression — Backward compatibility with MNP 4 & 5. Yields up to 4:1 data compression with rates up to 57.6Kbps for even greater line charge savings.

AT command set compatible — Provides asynchronous dial/autodial capability and convenient modem configuration through the terminal. Extended commands provide status information on the cellular network.

Additional features — 2-wire leased line operation, storage of four phone numbers, returns connect messages, auto dial/auto answer, software volume control. Includes fax software, manuals and cables for cellular and wireline connection.

SPECIFICATIONS

Data and Fax Modem Connection

PSTN — Direct connect to PSTN with internal DAA

Cellular — Direct connect to Motorola MC^2 MicroTAC cellular phones

Fax Modem Specifications

Compatibility — CCITT Group III compatible when used with Class 1 fax software

Data Rates — 14400, 12000, 9600, 7200, 4800, 2400, 300 bps

Operation — Half-duplex over 2-wire lines

Modulation — 14400/12000/9600/7200 bps, QAM; 4800/2400 bps, DPSK; 300 bps, FSK

Data Modem Specifications

Data Rates — CCITT V.32bis/V.32 14400, 12000, 7200 bps coded, 9600 bps coded or uncoded and 4800 bps uncoded; CCITT V.22bis 2400 bps and V.22 1200 bps; Bell 103 300 bps

Operation — 2-wire full duplex dial-up and cellular

Modulation — 14400, 12000, 9600, 7200, 4800 and 2400 QAM with suppressed carrier (CCITT V.32bis, V.32 and V.22bis); 1200 PSK (V.22); 300 FSK (Bell 103)

Data Compression — MNP level 5 and CCITT V.42bis

Error Control — MNP levels 2-4 and CCITT V.42 LAPM

Transmitter Frequencies — 1800 Hz (CCITT V.32bis/V.32); 1200 Hz originate, 2400 Hz answer (CCITT V.22bis); originate mark 1270 Hz, originate space 1070 Hz, answer mark 2225 Hz, answer space 2025 Hz (Bell 103)

Transmitter Output Levels — -9 dBm permissive (PSTN operation)

Receiver Dynamic Range — -43 dBm

Disconnect Options — Loss of carrier disconnect; DTR drop disconnect; long space disconnect

Test Modes — V.54 compatible loopback tests

Digital Interface — PCMCIA 2.01 compatible

Environmental — Operating temperature 0° to 50° C; storage -40° to 70° C

Size — 3.37 inches (85.6 mm); 2.16 inches (54.0 mm); 0.2 inches (5.0 mm)

Power Requirement — 150 mA (data mode)

## (M) MOTOROLA

KeepInTouch™ Card
PCMCIA 14,400 bps
Data and Fax Modem

AT&T's KeepInTouch Card is an all-in-one, high-speed data and fax modem that sends and receives files over both the standard telephone network and cellular communications lines. Based on technology developed by AT&T Paradyne and AT&T Bell Laboratories, the KeepInTouch Card complies with the PCMCIA (Personal Computer Memory Card International Association) standard used by the newest generation of low-profile notebook, palm-top, and pen-based portable computers.

Most important, the KeepInTouch (KIT™) Card is based on the software-defined architecture that was developed by AT&T Paradyne for its COMSPHERE® 3800 Family of Software-Defined Modems, winner of the PC Magazine Editors' Choice® Award.

BENEFITS
- Software-defined architecture increases product life and versatility
- Superior cellular and phone line capabilities ensure increased throughput and higher connection rates, increasing productivity and reducing connection charges
- Integrated data and fax functions in a single platform simplifies operation and increases productivity
- Unparalleled compatibility with PC's
- Low power consumption plus idle and sleep modes extend PC battery life
- Enhanced modulation compatibility ensures interoperability with lower-speed modems
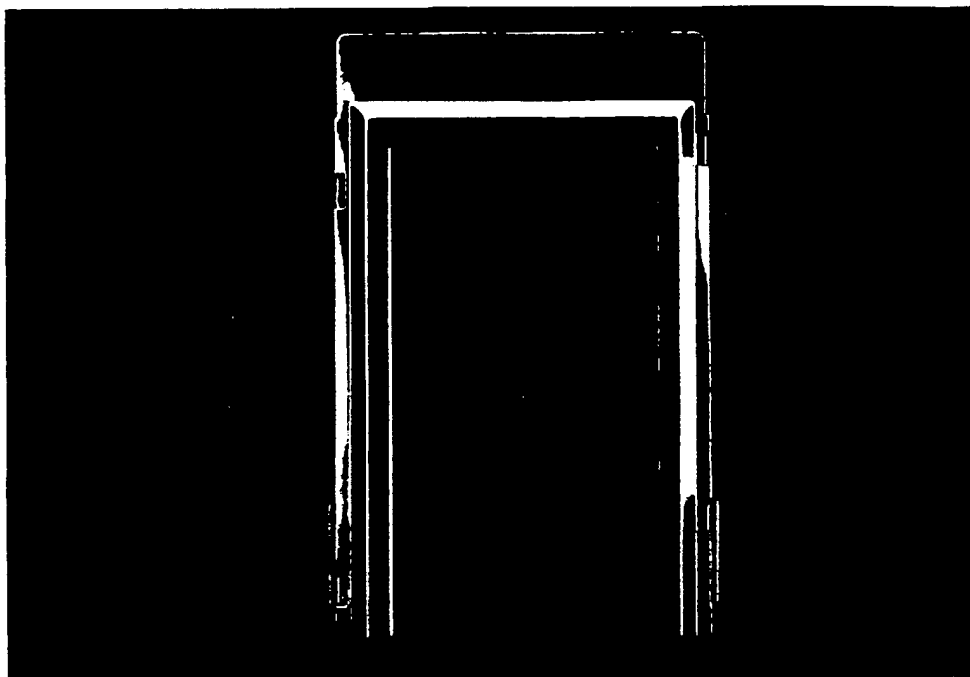
- AT&T's unequaled standards for reliability and performance assure customer satisfaction
- Enhanced user friendly installation and operation

OVERVIEW
With the KeepInTouch Card, AT&T introduces a major advancement in any-time, anywhere data communications for individuals who must remain productive and accessible, even when away from the office or home.

The KeepInTouch Card features state-of-the-art technology, exclusive to AT&T. Its patented, error-correcting Enhanced Throughput Cellular (ETC™) algorithm provides the most reliable cellular communications available today. Plus, as a member of the family of Software-Defined Modems, the KeepInTouch Card's unique architecture allows new modem enhancements to be downloaded from the AT&T Software Support Center. This approach guarantees increased functionality and flexibility for future applications, thus increasing product life. The KeepInTouch Card also features the sophisticated, award-winning data pump designed by AT&T Paradyne and Bell Laboratories.

In addition to data transfer, this versatile modem can send and receive faxes; it exchanges text and images with fax machines, increasing productivity while reducing expenses.

FEATURES
- Exclusive software-defined architecture that permits downloading of new modem features and enhancements
- AT&T's patented algorithm, ETC, ensures superior data throughput, over cellular communication links
- Ability to directly interface to many popular cellular phones, increasing performance and portability
- CCITT V.32bis modulation, V.42 error control, and V.42bis data compression with data terminal equipment (DTE) rates up to 57,600 bps
- High-speed send and receive fax capabilities that support Group 3, Class 1 and Class 2 with up to 14,400 bps transmission speeds (V.17)
- Miniaturized line interface cables
- Install program that maximizes compatibilty with PCMCIA PCs.

PERFORMANCE

The KeepInTouch Card is a full-featured V.32bis data/fax modem that complies with the PCMCIA standard. Delivering line speeds up to 14,400 bps, its high-speed design also ensures full compatibility with a wide variety of modulation schemes and functions.

As a result of its software-defined architecture, V.42 error correction, and V.42bis data compression, plus ETC, the KeepInTouch Card provides truly flexible, reliable high-speed communications that meet the demands of today's business travelers. It extends AT&T's leadership in high-speed data communications to the most personal, practical level with the assurance of unsurpassed quality, reliability, and customer support that only AT&T can provide.

SPECIFICATIONS

PC Card Standards
Compliance
PCMCIA Release 2.01, Type II; JEIDA 4.1
Architecture
Software-definable
Modulations
CCITT V.32bis 14,400 bps, 12,000 bps, 9600 bps and 7200 bps Trellis-Coded Modulation (TCM); 4800 bps Quadrature Amplitude Modulation (QAM)
CCITT V.32 9600 bps TCM; 4800 bps QAM
CCITT V.22bis 2400 bps QAM
CCITT V.22 1200 bps, Differential Phase-Shift Keyed (DPSK)
CCITT V.23 1200 bps, DPSK
AT&T 212A 1200 bps, DPSK
AT&T 103J 300 bps, asynchronous, Frequency Shift Keying (FSK)
CCITT V.21 300 bps, asynchronous, FSK
Automode
V.32bis, V.32, V.22bis, V.22, AT&T 212A, AT&T 103J

Autorate Fall Back/Forward
14,400 bps, 12,000 bps, 9600 bps, 7200 bps, 4800 bps
Data Compression
CCITT V.42bis
MNP Class 5
Error Control
CCITT V.42
MNP Class 4-2
Cellular Support
Patented ETC algorithm
Direct connection to cellular phones
DTE Data Rates
115,200 bps, 57,600 bps, 38,400 bps, 19,200 bps, 14,400 bps, 12,000 bps, 9600 bps, 7200 bps, 4800 bps, 2400 bps, 1200 bps, 0-300 bps, Autobaud all rates
Line Signaling Rates
14,400 bps, 12,000 bps, 9600 bps, 7200 bps, 4800 bps, 2400 bps, 1200 bps, 0-300 bps
Network Interface
Dial Line: Single six-position RJ11C with DAA
Direct-connect support to various cellular phones
FAX
CCITT V.17, V.29, V.27ter
EIA/TIA 578 Class1 and Class 2
Group 3 Send-and-Receive
Data Format
Serial, binary, asynchronous
Hayes AutoSync® protocol for synchronous transmission
Flow Control
RTS/CTS
XON/XOFF
Transmit Level
Permissive: -10 +/- 1 dBm
Configurable: -10 to -25 dBm in 1 dB steps
PC Operating Systems
DOS
OS-2

Dialing
Pulse/tone
Stored Configurations
One factory-preset
Two user-definable presets
Test Functions
Local (analog) loopback (TX to RX)
Remote digital loopback (RX to TX)
Digital loopback (RX to TX)
Self test
Transmit and receive 511 pattern
Remote digital loop and pattern
Local (analog) loopback and pattern
Command Buffer
40 characters
Phone # Storage
2 numbers
Communications Port Support
COM 1, 2, 3, 4
Operational Modes
Manual dialing and answering
DTE-controlled dialing and answering with AT command set
AT command set
TIA/EIA 602
Special Functions
Onboard 16550 buffered UART
Hayes AutoSync
Power Consumption (4 modes)
Operating: 950 mwatts
Stand-by: 15 mwatts
Idle: 475 mwatts
Off: 0 mwatts
Safety Certification
UL1950 per NEC 800-51
CSA C22.2, No. 950 per CEC
EN-60950
EN-41003
Emissions Certification
FCC Part 15, Class B
CISPR 22-B
EN-55022
**Line-Access Certification**
FCC Part 68
DOC CS-03

For additional information on this or any AT&T Paradyne product contact the office nearest you. Or, dial toll free (USA and Canada) 800 482-3333. Fax (USA) 813 530-2103.

Toronto 905 709-5000 fax: 905 709-3469
Montreal 514 288-0001 fax: 514 288-1246
Europe 44 753-515000 fax: 44 753-550011
Japan 81 3 3206-2111 fax: 81 3 3206-2129
Hong Kong 852 543-0083 fax: 852 541-3767
Latin America 813 530-2330 fax: 813 532-5240

Call 800 554-4996 for the latest compatibility list of cellular phones and laptop computers.

Computer
ResellerNews
Editors'
Choice

The Zoom/PCMCIA™ FaxModem V.34C

Born to be wireless!
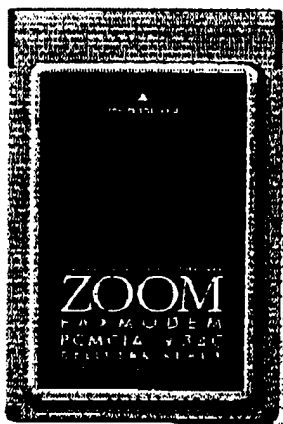
The Model 520 Zoom/PCMCIA FaxModem V.34C is a high-speed, ultraportable 28,800 bps faxmodem designed for both landline and wireless cellular communications. It features high connectivity and throughput in a small, plug-in package. Its small size, thin cord, rugged connector design, built-in DAA, cellular capability, advanced MNP 10EC™ Enhanced Cellular™ technology, PC Card-Guard™ digital PBX protection, and battery-conserving circuitry make the PCMCIA V.34C the perfect traveling companion.

Bundled software includes WinFax Lite™, DOSFax Lite™ and COMit™ data communications software for DOS and Windows™, plus a memory-saving enabler and card and socket services software.

The Zoom/PCMCIA FaxModem V.34C is a state-of-the-art faxmodem card that can be used with a notebook, palmtop, PDA, or any computer with a compatible PCMCIA slot in the office and on the road, as both a landline and cellular send-and-receive fax device and data modem.* It is a fully Hayes-compatible 28,800 bps V.34 modem and 14,400 bps send/receive fax device.**

Installing the PCMCIA FaxModem V.34C is fast and easy. Just plug it into a standard PCMCIA Type II, III, or Toshiba 16mm slot, and then attach by means of a thin cord to a telephone jack. The V.34C PCMCIA FaxModem provides "wired" communications when connected to a standard telephone line jack, and "wireless" communications when connected to a cellular telephone.

The PCMCIA FaxModem V.34C is cellular ready, with all required cellular circuitry onboard. No bulky cords or special adapters are required. You will need to order an inexpensive cellular phone activation kit that includes a thin cord and activation software for your cellular phone. Then you can use standard fax and data software for all faxmodem functions. Data rates depend on the quality of the cellular connection. To assure the highest cellular connectivity and data transfer rates, the PCMCIA FaxModem V.34 includes advanced MNP 10 Enhanced Cellular (MNP 10EC) hardware and firmware.

The PCMCIA FaxModem V.34C is equipped with PC Card-Guard, a special feature that fully protects the modem's circuitry from damage if it is accidentally connected to a digital PBX phone jack. PC Card-Guard senses and diverts excessive current before it can damage the faxmodem.

A sleep mode option conserves power when the PCMCIA FaxModem V.34C is running on a computer's battery. When the faxmodem is in sleep mode, it "wakes up" when it senses activity, such as a modem command or an incoming call.

The Zoom/PCMCIA Faxmodem V.34C is made in the USA by Zoom Telephonics, Inc.. an industry leader in telecommunications since 1977.

* Check for compatibility with your computer. Call 1-800-US-PCMCIA (1-800-877-2624)

** Speeds cited are for wired connection. Maximum speed achievable over cellular connections may be significantly lower.

ZOOM

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Web Site: http://www.zoomtel.com
BBS: 617 423-3733

Features

- True V.34 (ITU international standard) Technology.
- 100% Hayes AT Command Set Compatible, with Extended MNP 5 and V.42bis Command Set.
- Compatible with most PCMCIA Type II, III, and Toshiba 16mm slots.
- Supports both the V.34 ITU standard and V.Fast Class (V.FC) at 28,800 bps. Fully compatible with all other international standards, including 14,400 bps (V.32bis) and slower speeds.
- Fully integrated DAA phone line interface – no bulky cords or adapters.
- "Flash" memory for easy firmware upgrades.
- Low-power circuitry with energy-saving "Sleep Mode" to minimize computer battery drain.
- 28,800/26,400/24,000/21,600/19,200/16,800/14,400/12,000/9600/7200/4800/2400/1200/300 bps data pump.

Features (continued)

- 14,400/9600/7200/4800/2400/1200/300 Send/Receive Fax with automatic speed selection. Group 3, Class 1 and 2
- Automatically negotiates and maintains the highest mutually supported level of error correction, data compression, and modem speed .
- Auto-fallback/Fall forward Automatic Speed Selection and Adaptive Equalization.
- V.42 (LAPM) and MNP 2-4 error correction.
- V.42bis and MNP 5 data compression for effective speeds to 115,200 bps.
- MNP 10EC Enhanced Cellular protocol dramatically enhances performance over cellular or other poor quality lines. Also supports MNP* 10 and LAPM. Fully Hayes AT-Command set compatible.
- Supports many popular cellular phones; a cellular phone activation kit is required.
- PC Card-Guard protects against PCMCIA card blow-out from digital PBX phone systems.
- Digital and analog loopback diagnostics.
- Auto-dial (tone and rotary) and Auto-answer.
- FCC Registered (Part 68) and Certified (Part 15B).
- Recognized to U.S. and Canadian requirements under the Component Recognition Program of Underwriters Laboratories Inc.

ZOOM

207 South Street
Boston, MA 02111
617-423-1072
800-666-6191
AOL Keyword: ZOOMT
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The Zoom V.34I and V.34X FaxModems

About the Zoom/FaxModems V.34I and V.34X

The Zoom/FaxModem V.34I internal and V.34X external are full-featured 28,800 bps modems that support both the international V.34 standard and the V.Fast Class (V.FC) standard for 28,800 bps data transmission. They also support Class 1 and Class 2 fax at speeds up to 14,400 bps. Since these faxmodems also support the international standards at slower speeds and can automatically adjust to slower speed modems and faxmodems, they will communicate with virtually any modem or fax machine in the world.

The Zoom/FaxModem V.34I and V.34X are designed for high-speed, error-free communications. Both V.34 and V.FC use adaptive line probing and multi-dimensional trellis coding techniques to achieve very high data throughput and reliable connections. They can typically communicate at 28,800 bps with an-other V.34 or V.FC modem, even with uncompressible data. When the data can be compressed using the built-in V.42bis and MNP compression, even higher speeds can be achieved. They also support V.42 and MNP automatic error correction, and MNP10 for more reliable cellular, transcontinental, and interna-tional communications. Since all these standards are hardware-based, all connections are automatically negotiated for the fastest speed and the highest possible level of compression and error correction supported by both modems.

The Zoom/FaxModem V.34I and V.34X also support the V.17 fax standard for fax speeds up to 14,400 bps when communicating with other V.17 compatible modems and fax machines, and at 9600 bps for most other fax machines. For many applications you'll find these products are faster, easier and pro-duce results that are superior in quality to a conventional fax machine. They make it easy to "broadcast" personalized faxes to groups of people, to schedule fax deliveries when connection rates are low and to forward a fax with no loss of clarity. The quality of faxes sent with a Zoom/FaxModem is far better than the quality of those sent using a fax machine.

The Zoom/FaxModem V.34I and V.34X support the complete Hayes command set, plus all the Microcom commands required for MNP operation. It is built in the USA by Zoom Telephonics, Inc., a leading supplier of telecommunications equipment since 1977, and backed by Zoom's outstanding 7 year warranty.

Features

- True V.34 (ITU international standard) Technology
- Rockwell V.FC Technology for maximum compatibility with the installed basic 28,800 bps modems
- 100% Hayes AT Command Set Compatible, with Extended MNP 5 and V.42bis Command Set
- 28800/26400/24000/21600/19200/16800/14400/12000/9600/7200/4800/2400/1200/300 bps V.34/V.FC/V.32bis Data Pump
- 14400/12000/9600/7200/4800/2400 Group 3 Fax, Class 1 (EIA/TIA 578) and Class 2 (EIA/TIA 592)
- Automatic Adaptive Equalization
- Automatic Speed Sensing-automatically adjusts to calling modem
- V.42bis and MNP 5 data compression

- MNP 10 with "Adverse Channel Enhancement" for reliable cellular, international, and rural communication with V.22bis, V.32 and V.32bis
- V.42 compliant error correction (LAPM and MNP)
- V.17 protocol for 14,400 bps fax capability
- Auto-negotiation of highest level of compression (V.42bis, MNP 5) and error-correction (V.42, MNP 2-4, MNP 10) at speeds from 300 to 28,800 bps
- High-speed 16550 UART with 16-byte bi-directional buffer for faster data throughput (internal only)
- Ability to manually force MNP 5, V.42bis, V.42 or MNP 4
- Auto-dial/Auto-answer
- Tone and Pulse Dialing - software switchable
- Adaptive Dialing (user selectable)
- Call Progress Tone Decoding - busy, ring and dialtone
- Line quality monitor and retrain capability
- Phone Directory (four 30-digit numbers stored in non-volatile memory)

- 15 LED Status Indicators (external only)
- Caller ID hardware (external only)- (requires apprpriate soft ware and caller ID service from your phone company)
- Dual RJ11 Phone Jacks - one for phoneline, one for optional phone
- Audio Speaker with software volume control
- Non-volatile Configuration Storage in NVRAM
- Automatic Gain Control
- Automatic terminal to modem speed sensing between 300 and 115,200 bps
- Speed Buffering/Flow Control
- Inactivity Timer - when set, causes hang up if no data for programmable time (1-42 minutes)
- Extensive communication software compatibility
- 7 Year Warranty

Technical Specifications

Data Encoding	28800/26400/24000/21600/19200/16800/144000 -V.34/V.FC 14400/12000/7200 bps - V.32bis 9600/4800 bps - V.32 2400 bps - V.22bis 1200 bps - Bell 212A, V.22. 300 bps - Bell 103, V.21, V.22 A/B, V.23	Dialing Capability	DTMP (Touchtone) and Pulse Dial, Programmable DTMF Tone Duration
		Command Buffer	40 Characters
		S-Registers	S0 through S41, S44, S46, S48, S80, S82, S86, S95
Fax Encoding	14400/12000 bps - V.33, V.17 9600/7200 bps - V.29, V.17 4800/2400 bps - V.27 ter 300 bps - V.21 channel 2	Non-Volatile Storage	Commands Stored: B E L M N P or T Q V W X Y &C &D &G &J &K &P &Q &R &S &T &X &Y S-Registers Stored: S0, S6-12, S14, S15, S18, S21-23, S36, S37, S40, S41, S44, S46, S48, S95
Flow Control	RTS/CTS, XON/XOFF, transparent XON/XOFF, modem-to-modem	MNP Commands	%C &Q5 \W \A \B \E \G \K \L \N \O \T \U \Y \Z
		MNP S-Registers	S36 S38 S40 S41
Terminal-to-Modem (DTE)Data Rates	115200/57600/38400/19200/14400/9600/7200/4800/ 2400/1200/300	V.42 Registers	S36 S46 S48 S82 S86 S90 S91
		Audio Monitor	High efficiency transducer

"AT" Automatic Speed Sense Data Formats	Parity	Data Length	Stop Bits
	Odd	7	1
	Even	7	1
	None	8	1

Terminal Interface	CCITT V.24 (EIA-232-D) compatible Female DB25 connector, 16 signal lines supported
Diagnostics	EIA TR30.2 (Analog Loopback, Analog Loop Self-Test, Remote Digital Loopback, Remote Digital Loopback with Self-Test, Digital Loopback)	Telephone Interface	Modular phone jacks (two RJ11 type)
		Configuration	Stand-alone (external) Fits PC compatible slot (internal)
Operation	Full Duplex over Two-wire Switched Lines. Automatic or Manual Originate and Answer Modes	Power Supply Cube	105 VAC, 60 HZ input 9 VAC at 1A nominal output UL Listed (external only)
Equalization	Automatic Adaptive Equalization and Gain Control	Size	6.125"W by 8.5"L by 1.625" H (external) 2.7"W by 5.4"L by .75"H (internal)
		Compliance	FCC Parts 15B, 68, UL Listed Canadian ISC and CSA Listed

ZOOM

APPENDIX 4D

FUJITSU SYTLISTIC 500 PRODUCT

FUJITSU
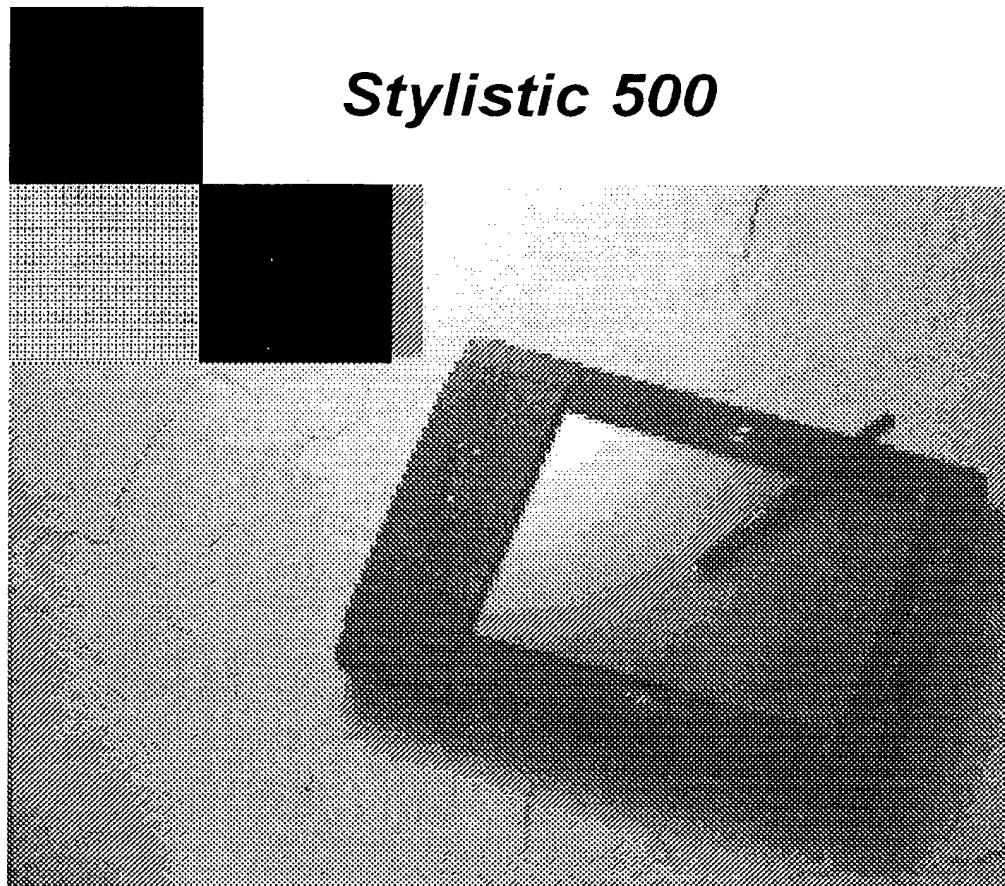
Stylistic 500

The Stylistic 500™ from Fujitsu Personal Systems, Inc. is the lightest, most powerful PC tablet on the market today. Powered by an Intel486 DX2-50 microprocessor, it brings the computing power of desktop workstations to mobile workers. And, at less than three pounds, the Stylistic 500 can be used in a wide variety of field decision support applications where light weight and high performance are essential.

Stylistic 500

TECHNICAL SPECIFICATIONS

Form Factor

Small Tablet size, pen-based computer

Overall Dimensions
7.2" x 10.7" x 1.5"
182mm x 272mm x 37mm

Weight
2.6 lbs (1.2Kg) with two batteries

Architecture
IBM PC AT compatible

Microprocessor
Intel486 DX2 50MHz
8KB On-Chip Cache
Integrated Math Coprocessor

System Memory
4MB DRAM standard
Upgradeable to 20MB

Memory Expansion
4MB, 8MB and 16MB DRAM Cards

BIOS
128KB Flash ROM

Expansion
One ATA Slot (Mass Storage)
Accepts Type III PCMCIA-ATA harddisk card (105MB/170MB) or Type Solid-state flashcard (SunDisk 5MB-40MB)

Two PCMCIA 2.2 Slots
Accepts two Type I/II PCMCIA cards or one Type III PCMCIA card

Display
Backlit Transmissive LCD
8" (203mm) diagonal, 0.25mm dot pitch
640 x 480 VGA resolution, 64 gray scales

Digitizer
Electromagnetic digitizer tablet
1016 points/inch resolution
153 points/second sampling rate

Interfaces
Keyboard (PS/2-style)
Parallel (EPP)
VGA (simultaneous with LCD)
RS-232C Serial
Infrared Serial
External Floppy Disk Drive

Power
Two Lithium-Ion Battery Packs
(interchangeable with Sony NP-500H)
Autosensing 100-240V AC Adapter

Battery Life
2-5 Hours (application dependent)

Power Management
Save To Disk, Suspend and Doze Modes
Selectable Subsystem power reduction
via idle timers
Supports Intel and Microsoft APM

Options
Memory Expansion Cards
(4MB, 8MB, 16MB DRAM-JEIDA)
PCMCIA-ATA Hard Disk Cards
PCMCIA Cards such as:
*Fax/DataModem, LAN, Wireless LAN
Solid-State Flash and SRAM*
Hand Strap
Stylus Tether
External 3.5" Floppy Disk Drive
Keyboard *(low-power)*
External Battery Charger
Auto Adapter
AC Adapter *(spare)*
Stylus Kit *(spare)*
Li-Ion Battery Pack *(spare)*
Desk Stand
Carrying Cases *(Slipcase, Harsh Environment Case, Keyboard Combo Case)*
Cradle
Docking Station

Software
Operating System
MS-DOS

Operating System
Windows for Pen Computing
PenRight!
PenDOS

Environmentals
Temperature
0 to 35 C (32 to 95 F)
Operating
-20 to 60 C (-4 to 140 F)
Non-operating

Humidity
20%-85% RH (Non-condensing)
Operating
8%-95% RH (Non-condensing)
Non-operating

Altitude
-200ft to 10,000ft (-61m to 3,047m)
Operating
40,000ft (12,189m) maximum
Non-operating

Approvals
Emissions
FCC Class B, VDE Level B
DOC Class B, CISPR 22 Class B

Safety
UL 1950, CSA 950, TUV IEC950

Warranty
Three years, limited, parts and labor.
Extended warranties available. Optional
three year no-fault screen warranty

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FUJITSU PERSONAL SYSTEMS, INC.
5200 Patrick Henry Drive
Santa Clara, CA 95054

58-0350-00A

Fujitsu Stylistic 500   U.S. SRP - Effective 8/01/95

FMW #	Description	SRP

System Unit

FMW2220A	**Fujitsu Stylistic 500** A 2.6 pound portable, pen-based tablet computer. Measures 7.2" x 10.7" x 1.5". Features a 50MHz 486DX2 CPU, 4MB DRAM, 1 ATA slot, 2 PCMCIA Type II slots, backlit transmissive VGA LCD display, RS-232 serial, parallel, monitor, keyboard, infrared and floppy disk drive ports. The Stylistic 500 supports multiple pen operating environments. Three year limited warranty. System also includes: • User's Guide • AC Adapter • Quick Reference Card • Stylus and extra tips • 2 Removable/rechargeable Lithium-Ion battery packs *Requires an operating system and mass storage (hard drive or SunDisk)*	$2,175
FMW2220A06	**Fujitsu Stylistic 500 w/170MB HDD, MS-DOS and Windows for Pen Computing** FMW2220A with: • FMWHC170S1 170MB HDD with MS-DOS 6.20/Windows for Pen/CIC HRS	$3,050
FMW2220A15	**Fujitsu Stylistic 500 w/260MB HDD, MS-DOS and Windows for Pen Computing** FMW2220A with: • FMWHC260S1 260MB HDD with MS-DOS 6.20/Windows for Pen/CIC HRS	$3,160
FMW2220A09	**Fujitsu Stylistic RF** FMW2220A with built-in Proxim RangeLAN2 frequency hopping radio for use in wireless LAN environments. Integrated Proxim radio occupies both slots of the PCMCIA bay. Indoor range 200-500 feet. Outdoor range 1,000 feet. Data rate: 1.6 Mbps. One available ATA slot (Accepts Type III PCMCIA-ATA hard disk card or Type II solid-state flash card). Three year limited warranty on FMW2220A. One year limited warranty on Proxim radio. Network Operating Systems supported: NetWare 2.X, 3.X, 4.X, Personal NetWare Client Drivers, TCP/IP protocols. System also includes: • Stylistic 500 User's Guide • Stylistic 500 User's Guide RF Addendum • AC Adapter • Stylus and extra tips • 2 Removable/Rechargeable Lithium-Ion battery Pack • Quick Reference • Proxim RangeLAN2 PCMCIA Use • ODI and NDIS software drivers/enablers on 3.5" diskettes *FMW2220A requires an operating system and mass storage (hard drive or SunDisk). Wireless communication requires two or more devices equipped with RangeLAN2 radios. One Stylistic RF may communicate wirelessly with another Stylistic RF, or a Proxim RangeLAN2 Access Point, or a PC AT-compatible computer equipped with a Proxim RangeLAN2 ISA LAN adapter, radio & external antenna, or a PC AT-compatible computer equipped with a Proxim PCMCIA LAN adapter, external radio & antenna. Seamless, wireless roaming is only allowed with two or more Proxim RangeLAN2 Access Points. In addition, a network operating system such as Novell NetWare, Personal NetWare, or TCP/IP protocols, as well as ODI or NDIS drivers, must be installed on all devices which communicate wirelessly with each other.*	$3,295
FMW2220A11	**Fujitsu Stylistic RF w/170MB HDD, MS-DOS and Windows for Pen Computing** FMW2220A09 with: • FMWHC170S1 170MB HDD with MS-DOS 6.20/Windows for Pen/CIC HRS	$3,995
FMW2220A17	**Fujitsu Stylistic RF w/260MB HDD, MS-DOS and Windows for Pen Computing** FMW2220A09 with: • FMWHC260S1 260MB HDD with MS-DOS 6.20/Windows for Pen/CIC HRS	$4,295

Fujitsu Stylistic 500   U.S. SRP Pricing - Effective 8/01/95

FMW #	Description	SRP

Mass Storage Options and Operating System/Environment Options

PCMCIA Hard Drive Cards

Rotating magnetic media for use in the ATA slot or PCMCIA slot. Similar to a hard disk drive in a desktop system but in PCMCIA form factor (Type III). User installable option. *Requires operating system when used as a boot drive.*

FMW #	Description	SRP
FMWHC170	**170MB PCMCIA-ATA Hard Drive** *Operating System not included.*	**$895**
FMWHC170S1	**170MB PCMCIA-ATA Hard Drive with MS-DOS 6.20 and Windows for Pen Computing** MS-DOS 6.20 and Windows for Pen Computing pre-installed on the drive. Includes CIC Handwriter Recognition System.	**$985**
FMWHC260	**260MB PCMCIA-ATA Hard Drive** *Operating System not included.*	**$960**
FMWHC260S1	**260MB PCMCIA-ATA Hard Drive with MS-DOS 6.20 and Windows for Pen Computing** MS-DOS 6.20 and Windows for Pen Computing pre-installed on the drive. Includes CIC Handwriter Recognition System.	**$1,060**
FMWOS2	**MS-DOS 6.20** Set of 3.5" installation diskettes and User's Guide.	**$60**
FMWOS3	**Windows for Pen Computing** Set of 3.5" installation diskettes and User's Guide. Includes CIC Handwriter Recognition System.	**$125**
FMWOS4	**PenDOS 2.2** Set of 3.5" installation diskettes and User's Guide.	**$75**

SunDisks

Solid-state, mass storage for use in the ATA slot of PCMCIA slots. Functions like a hard disk drive but without magnetic media. PCMCIA form factor (Type II). User installable option. *Requires operating system when used as a boot drive.*

FMW #	Description	SRP
PQ-0649	**2.5MB SunDisk**	**$385**
PQ-0650	**5MB SunDisk**	**$530**
PQ-0651	**10MB SunDisk**	**$805**
PQ-0652	**20MB SunDisk**	**$1,375**

SRAM Cards

Solid-state storage for use in the PCMCIA slots. Functions like a hard disk drive but without magnetic media. PCMCIA form factor (Type I). Uses a lithium coin battery (included). User installable option.
Use as a secondary storage device, not a boot drive.

FMW #	Description	SRP
PQ-0621	**2MB SRAM Card, Rev 2**	**$560**

Fujitsu Stylistic 500   U.S. SRP - Effective 8/01/95

FMW #	Description	SRP

RAM Expansion Options

FMWEM4	**4MB DRAM Expansion Module** 4MB DRAM card which plugs into the JEIDA RAM expansion slot of the Stylistic 500. This module adds 4MB of system RAM to the Stylistic 500 for a total of 8MB of system RAM. User installable option. Cannot be combined with other RAM expansion modules.	$395
FMWEM8	**8MB DRAM Expansion Module** 8MB DRAM card which plugs into the JEIDA RAM expansion slot of the Stylistic 500. This module adds 8MB of system RAM to the Stylistic 500 for a total of 12MB of system RAM. User installable option. Cannot be combined with other RAM expansion modules.	$750
FMWEM16	**16MB DRAM Expansion Module** 16MB DRAM card which plugs into the JEIDA RAM expansion slot of the Stylistic 500. This module adds 8MB of system RAM to the Stylistic 500 for a total of 20MB of system RAM. User installable option. Cannot be combined with other RAM expansion modules.	$1,595

Optional Peripherals

FMWFD1	**External Floppy Disk Drive** 3.5, 1.44MB external floppy disk drive. Battery and AC powered. Includes batteries and cables. Connects to the Floppy Disk Drive (FDD) port on the Stylistic 500. User installable option. *Requires batteries (included) or Stylistic 500 AC Adapter for operation.*	$350
FMWFDC1	**Cables for Stylistic 500 External Floppy Disk Drive** Interface cable and DC cable. Converts Fujitsu 325Point External Floppy Disk Drive (Model # PQ-0512) into Stylistic 500 External Floppy Disk Drive. *Cables Only. Requires External Floppy Disk Drive.*	$68
FMWKB1A	**Stylistic 500 Keyboard** 84 key, AT style, low-power consumption keyboard. Attaches to the keyboard port on the Stylistic 500. User installable option. *Recommended for application developers.*	$90
FMWBP4	**Lithium-Ion Battery Pack** One removable and rechargeable Lithium-Ion battery to power the Stylistic 500. Can be used as an extra battery or as a replacement for a standard battery. User installable option. *Stylistic 500 holds up to 2 Batteries.*	$100
FMWBC1	**External Charger for Lithium-Ion Batteries** Holds two Stylistic 500 batteries; charges one battery at a time. Plugs directly into a 2-prong AC power outlet. User installable option.	$130
FMWBC3	**External Charger, DC-Input, for Lithium-Ion Batteries** Holds two Stylistic 500 batteries; charges one battery at a time. User installable option. *Requires AC Adapter or Auto Adapter.*	$225
FMWAC1A	**AC Power Adapter** 110/240 VAC auto-sensing AC Adapter. Can be used as an extra or replacement AC Adapter for the Stylistic 500. Includes AC power cable. User installable option.	$125
FMWCB1	**Auto Adapter** Powers the Stylistic 500 through vehicle cigarette lighter. User installable option.	$125

Fujitsu Stylistic 500   U.S. SRP Pricing - Effective 8/01/95

FMW #	Description	SRP
FMWST1	**Stylus Tether** Tether for Stylistic 500 Stylus. Tether attaches pen to the Stylistic 500 or to any of the 3 carrying cases. Helps to prevent accidental loss or dropping of pen. User installable option.	$18
FMWPN1	**Replacement Stylus Kit** Extra stylus for the Stylistic 500. Includes extra tips and batteries. User installable option.	$105
PQ-2513	**Scanteam 6700 Wand-Stylus** Bar Code wand which accepts the Stylistic 500 pen for single handed operation.	$475
	RangeLAN2/ISA Wireless ISA (XT or AT) form factor adapter & frequency hopping radio with external antenna. Indoor range 200-500 feet. Outdoor range 1,000 feet. Data rate: 1.6 Mbps. One year limited warranty on Proxim radio. Network Operating Systems supported: NetWare 2.X, 3.X, 4.X, Personal NetWare Client Drivers, TCP/IP protocols. Includes: • Installation Instructions • Proxim RangeLAN2 ISA User's Guide ODI & NDIS software drivers/enablers on 3.5" diskettes *Wireless communications requires two or more devices equipped with RangeLAN2 radios. A PC AT-compatible computer equipped with a RangeLAN2/ISA LAN adapter, radio & external antenna may communicate wirelessly with another PC AT-compatible computer equipped with a RangeLAN2/ISA LAN adapter, radio & external antenna, or a Stylistic RF, or a Proxim RangeLAN2 Access Point, or a PC AT-compatible computer equipped with a Proxim PCMCIA LAN adapter, external radio & antenna. Seamless, wireless roaming is only allowed with two or more Proxim RangeLAN2 Access Points. In addition, a network operating system such as Novell NetWare, Personal NetWare, or TCP/IP protocols, as well as ODI or NDIS drivers, must be installed on all devices which communicate wirelessly with each other.*	Call Proxim at 415-960-1630
	RangeLAN2/Access Point Bridge to 802.3 Ethernet LANs that supports multiple Stylistic RF units employing wireless, frequency hopping technology. A single Access Point allows wireless roaming within its range. Multiple Access Points enable seamless, wireless roaming across Access Point geographical boundaries. Single Access Point indoor range 200-500 feet. Outdoor range 1,000 feet. Data rate: 1.6 Mbps. Network Operating Systems supported: NetWare 2.X, 3.X, 4.X, Personal NetWare Client Drivers, TCP/IP protocols. Includes: • Installation Instructions • Proxim RangeLAN2/Access Point User's Guide ODI & NDIS software drivers/enablers on 3.5" diskettes *Wireless communication requires two or more devices equipped with RangeLAN2 radios. An Access Point may communicate wirelessly with a Stylistic RF, a PC AT-compatible computer equipped with a Proxim RangeLAN2 PCMCIA LAN adapter, external radio & antenna, or a RangeLAN2/ISA LAN adapter, radio & external antenna. In addition, a network operating system such as Novell NetWare, Personal NetWare, or TCP/IP protocols, as well as ODI or NDIS drivers, must be installed on all devices which communicate wirelessly with each other.*	Call Proxim at 415-960-1630

Optional Accessories

FMW #	Description	SRP
FMWHS1	**Hand Strap, Landscape** Strap for holding Stylistic 500 in landscape mode applications. Attaches to mounting points on the back of the Stylistic 500.	$39
FMWHS2	**Hand Strap, Portrait** Strap for holding Stylistic 500 in portrait mode applications. Attaches to mounting points on the back of the Stylistic 500.	$39

Fujitsu Stylistic 500   U.S. SRP - Effective 8/01/95

FMW #	Description	SRP
FMWCC1	**Cordura Slip Case** Protective Cordura slip case for the Stylistic 500 system unit. Allows access to Stylistic 500 suspend/resume control, keyboard, DC-In and I/O Connectors, PCMCIA pop-out door and system On-Off switch. Pen holder, hand strap, detachable shoulder strap and carrying handle included.	$95
FMWCC2	**Harsh Environment Case** Foam-laminate material and Lexan window enclose the Stylistic 500 to increase resistance to dust, moisture, shock and vibration. Two zippers and a velcro flap allow easy removal/insertion of the Stylistic 500 computer. The window over the main display and status display area has a scratch-resistant and anti-glare coating, allowing easy use of the pen. The following functions operate with the case on: suspend/resume control and hot pads (contrast, backlight, speaker & monitor controls). A velcro flap provides access to DC-In and keyboard connectors, and PCMCIA pop-out door. Carrying handle, hand strap, pen holder and detachable shoulder strap included.	$210
FMWCC4	**Harsh Environment Case for Stylistic RF** Similar construction to Harsh Environment Case for Stylistic 500, with special aperture for the Stylistic RF antenna, and rigid handle.	$225
FMWCC3	**Combination Carrying Case for Stylistic 500 and Keyboard** Protective leather-like case for the Stylistic 500 System. Case opens to allow use of computer and keyboard in a "notebook style" position. Designed for quick insertion and removal of the Stylistic 500. Adjustable LCD viewing angle. Storage for AC Adapter, PCMCIA Cards and documents. Carrying handle and detachable shoulder strap included.	$225
FMWDS1	**Desk Stand** Desk Stand for Stylistic 500. Small footprint. One piece, non-folding, rigid Stand. Allows access to suspend/resume control, on-off switch, keyboard, DC-In and I/O Connectors, PCMCIA pop-out door, Pen Holder and Battery 1 Door. Adjustable viewing angle.	$95
FMWSP1	**ST500 Screen Protector - 12 Pack** Prevent scratches on the Stylistic 500 display in dusty or sandy environments. Clear screen protector is replaceable and has anti-glare coating.	$120

Cradles

Cradles are stationary docking receptacles for single system unit.

FMW #	Description	SRP
FMWCR2	**Cradle** Cradle for the Stylistic 500 which recharges the batteries and provides IR communications through Windows.	$995

Warranty Options

The limited three year warranty covers the Stylistic 500 base unit only. "No fault" screen warranties are available at an additional cost.

FMW #	Description	SRP
FMWSW1	**Stylistic 500 1-Year No Fault Display Warranty** Covers two screen replacements per year for any cause of screen damage. Warranty purchase must accompany Stylistic 500 purchase.	$60
FMWSW2	**Stylistic 500 3-Year No Fault Display Warranty** Covers two screen replacements per year for any cause of screen damage. Warranty purchase must accompany Stylistic 500 purchase.	$150

Pen Developer Options

Fujitsu Stylistic 500

FMW #	Description	SRP
FMW22TRG1	**Stylistic 500 Technical Reference Guide** Manual and Developer's Utilities diskette	$75
PQ-3113	**PenRight! Pro Toolkit** For experienced C programmers. Software development kit for building forms-based applications that accept pen-based input. Contains more than 230 routines. Development environment requires a minimum of a PC/AT with 2MB RAM and MS-DOS 3.3 or higher. *Note: PenRight! Runtime is required for each system unit running an application developed with PenRight!*	$795
PQ-3114	**PenRight! Runtime** This runtime is required when running PenRight! Pro or padBase applications *Note:* *PenRight! Runtime is required for each system unit running an application developed with PenRight!*	$145
	Power Pen Pal™ Toolkit Pen application development environment. No knowledge of C or PenRight! Pro is required. *Note: PenRight! Runtime and Power Pen Pal Runtime are required for each system unit running an application developed with Power Pen Pal.*	**Call Pen Pal at** **415-462-4888**
	Power Pen Pal™ Runtime Runtime required when running applications developed in Power Pen Pal. *Note: PenRight! Runtime is required for each system unit running an application developed with Power Pen Pal.*	**Call Pen Pal at** **415-462-4888**

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Prices, specifications and availability are subject to change without notice.

APPENDIX 4E

IBM THINKPAD POWER SERIES 820 AND 850

Next time you travel, make it a power trip

IBM

ThinkPad Power Series 820 and 850

AIX - AIX - 8999-3&Meg-1.
(-850 AIX
400 - CAMera
282 Video CAP

Highlights

- **100MHz PowerPC 603e™ processor with 32KB L1 cache provides advanced application support in a compact ThinkPad Power Series™ notebook computer**

- **256KB L2 cache reduces memory access time to boost processing speed**

- **16MB or 32MB parity memory expands to 48MB or 96MB, (depending on model)**

- **PCI-bus local-bus graphics for enhanced performance**

- **10.4" diagonal high-resolution SVGA (800 x 600) or VGA (640 x 480) Black Matrix TFT color displays**

- **Multimedia-ready with 16-bit business audio, CD-ROM drive, video playback, stereo speakers and microphone all built in**

- **Up to 1.2GB¹ of storage**

- **Video conferencing with optional snap-in video camera (Power Series 850 only)**

- **Choice of 32-bit advanced multi-tasking operating systems**

- **Three-year warranty with International Warranty Service**

PowerPC™

IBM.

IBM HelpWare service and support

Every IBM Personal Computer Power Series and ThinkPad Power Series you buy is backed by a three-year warranty with International Warranty Service.⁷ Personal Computer Power Series desktops come with one-year onsite, second- and third-year carry-in service. ThinkPad Power Series notebooks include ThinkPad EasyServ™ courier repair service at no additional charge during warranty period.⁸

Plus with every Power Series system you receive IBM's world-class HelpWare® customer support. You'll get expert assistance by toll-free telephone (1-800-772-2227) 24 hours a day, 7 days a week (excluding some holidays). Electronic support services include fax (1-800-IBM-3395), bulletin board (1-919-517-0001) or online services.

Put the IBM Power Series to work for you

From advanced business and technical applications to graphics and multimedia, the IBM Personal Computer Power Series and ThinkPad Power Series can handle your demanding workloads today, and tomorrow, too. For information on how to put Power Series systems to work for you, contact your IBM representative or IBM Authorized Reseller. For the name of a reseller near you, call 1-800-472-7693.

G520-7161-00

Next time you travel, make it a power trip!

Power to go
Workstation power. Who says you can't take it with you? The 100MHz IBM ThinkPad Power Series 820™ and 850™ notebook computers deliver more than mobile personal productivity. They're full-fledged, high-performance 32-bit systems that run demanding applications on countertops, coffee tables – even the factory floor. How? The PowerPC 603e™ processor can handle the same jobs as its desktop cousins. You can even upgrade memory to 48MB (ThinkPad Power Series 820) or 96MB (ThinkPad Power Series 850). It's RISC power to go, with all the portability and flexibility you expect from an IBM ThinkPad.

The visible difference
That power is more than matched by what you see on screen. The large 10.4-inch diagonal SVGA Black Matrix TFT display gives you 65,536 brilliant colors at up to 800 x 600 resolution. PCI local-bus graphics deliver lightning-fast performance. Business audio, microphone and internal stereo speakers all come standard. And the motion video adapter (optional on the Power Series 820) lets you play video full screen, at full frame rates. It's everything you need to make multimedia mobile. You can integrate your company's video into your presentations – or even add and edit your own video – and plug your notebook right into a TV. With the ThinkPad Power Series 850 you can snap in an optional video camera to capture footage or hold live video conferences over a single standard telephone line.

Storage and more
What's more, every ThinkPad Power Series comes equipped with an internal SCSI-2 double-speed CD-ROM drive and a removable hard-disk drive.
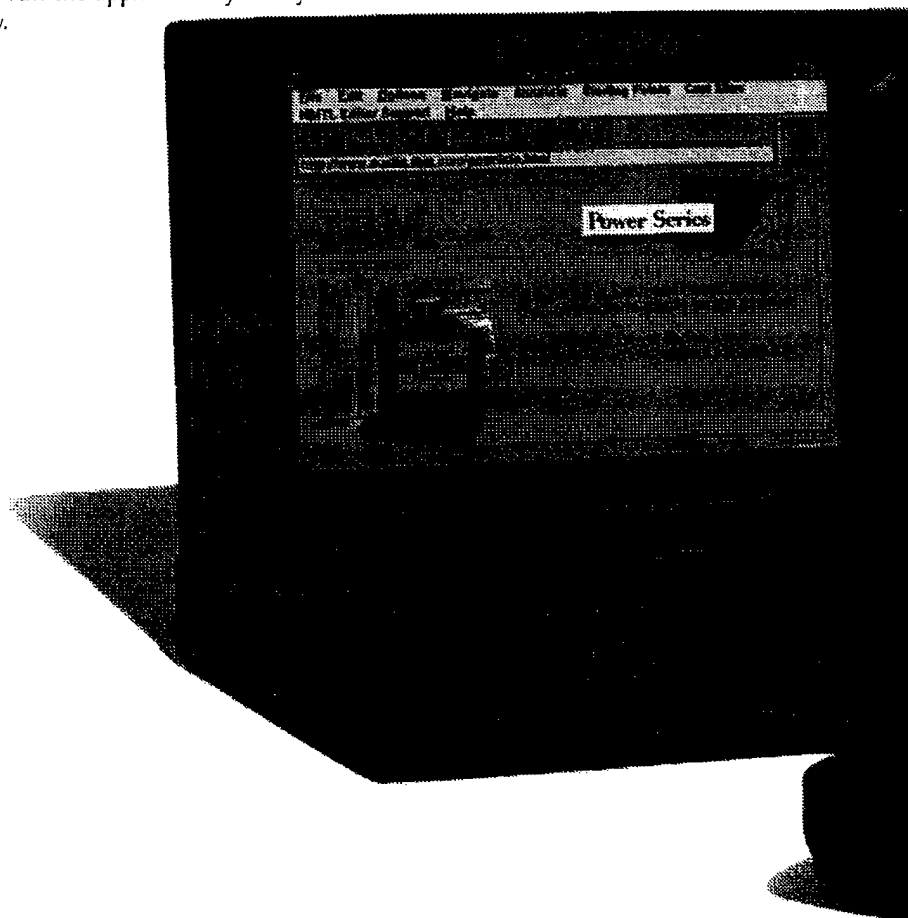
ThinkPad Power Series 820 and 850

Choose the hard-drive capacity that's right for you – 540MB; 810MB or 1.2GB – or take along more than one drive for more capacity.

Anyone in your organization who needs mobility – from technical users on-the-go to field personnel – can use production applications virtually anywhere. That's because ThinkPad Power Series notebooks can run the full range of demanding 32-bit applications under AIX or the PowerPC Editions of OS/2 Warp Connect, Windows NT and Solaris. Now you can have the resources you expect from a specialized workstation in a compact notebook computer... and still run the applications you rely on today.

Air speed

You don't have to stay grounded to benefit from PowerPC performance. The ThinkPad Power Series 820 and 850 sport a 100MHz PowerPC 603e processor with 32KB Level 1 cache plus 256KB Level 2 cache to deliver performance – anywhere, anytime

Point and shoot

Hold a personal
video conference
from any phone'
with the optional
video camera on
your ThinkPad
Power Series
850 and Personal
Conferencing
for AIX.
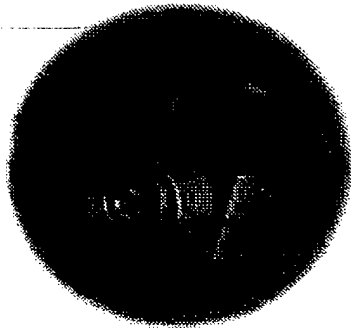
Mouse-free

Your ThinkPad
Power Series note-
book includes IBM's
innovative, integrated
TrackPoint™ III™ point-
ing device for pre-
cise, finger-tip control
with QuickStop
response and slip-
free caps. It offers
both outstanding
accuracy and
ergonomics – plus
you avoid the hassle
of carrying along
an external mouse.

A new resolution

You've had a look
at ThinkPad's innova-
tive displays. But you
haven't seen any-
thing until you team
them up with the
PowerPC processor!
You get 10.4-inch
diagonal TFT color
displays with Black
Matrix technology
for superior viewing
in even bright light.
Choose the high-
resolution, flicker-free
SVGA with 65,536
colors at 800 x 600
for higher resolutions
than many desktop
monitors.
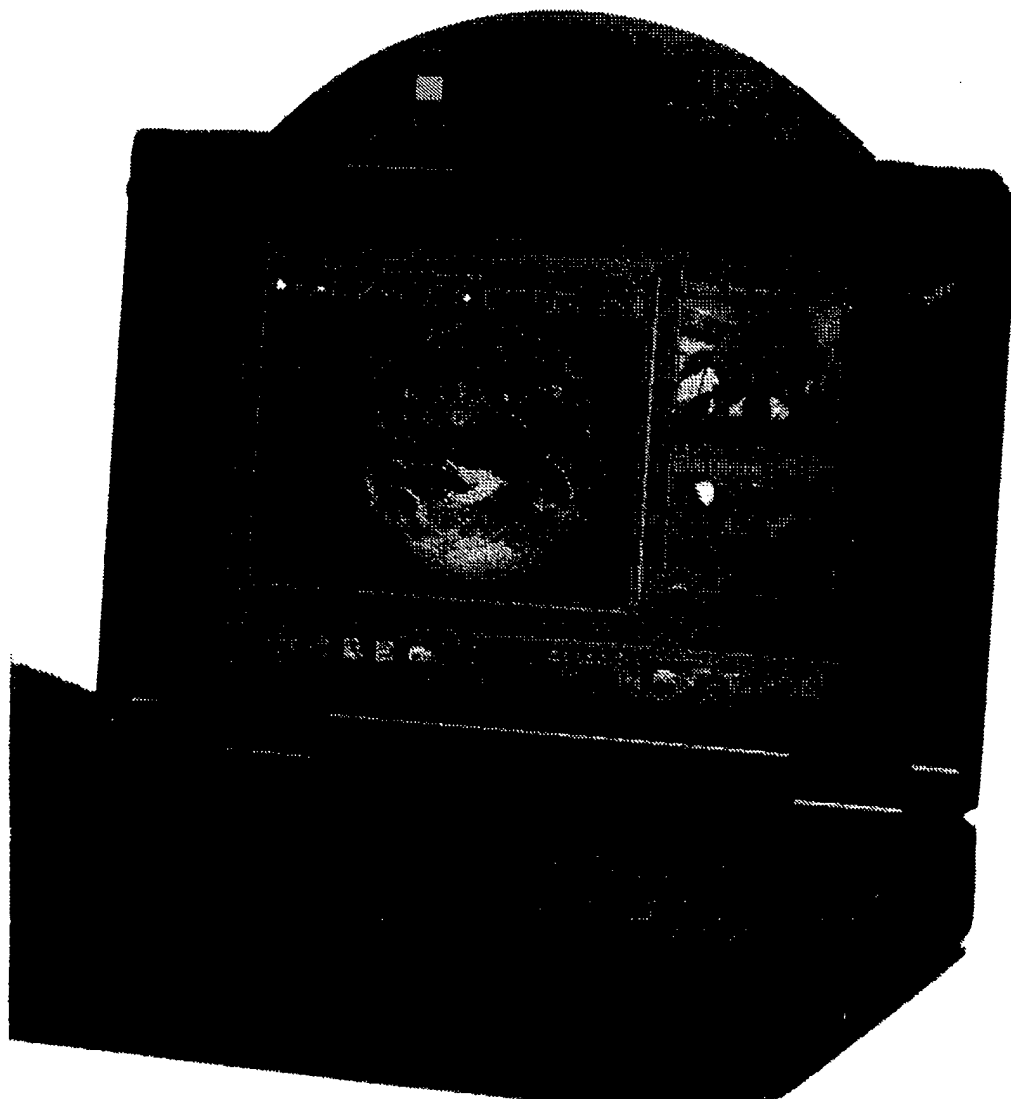
Power to go, from IBM

Now you can pump up the perform-
ance of your most demanding business
applications – and provide your mobile
workforce with the flexibility they need
to do all their work...any time, any
place. You can do all this and more with
the IBM ThinkPad Power Series 820™
and 850™ notebook computers.

With these muscular new notebooks
– built around the PowerPC 603e
processor – you can put the power
of RISC-based computing on the job
anywhere. The PowerPC 603e micro-
processor provides a leap in industry
leadership application performance
for notebooks through its 100MHz
speed, 32KB Level 1 cache and 256KB
Level 2 cache support.

With the PowerPC processor's inte-
grated floating-point unit and Level 1
cache, the ThinkPad Power Series 820
and 850 deliver superior performance
on floating-point operations. And with
the Power Series 820's 32-bit memory
bus or the Power Series 850's 64-bit
memory bus, you have open-ended
performance for applications you
thought you could only handle on a
desktop system – advanced business
programs, real-time interactive confer-
encing and more. You can even run
technical applications like software
engineering and scientific visualization
...anywhere you've got room to open
up a notebook.

At the same time, you get the innovative
features you've come to expect with
an IBM ThinkPad: large, state-of-the-art
TFT displays with glare-reducing Black
Matrix technology... plus IBM's industry-
leading integrated TrackPoint® III™ point-
ing device.

Room to grow

You can select exactly the capabilities
you need today, and add more func-
tion later if your needs change. For
example, the ThinkPad Power Series
820's standard 16MB or 32MB of
memory can expand to 48MB using
Memory Modules, while the ThinkPad
Power Series 850 can start with 16MB
or 32MB and go all the way to 96MB
with IC DRAM cards.

For applications that require lots of stor-
age, select a 540MB, 810MB or 1.2GB
SCSI-2 hard drive. Because these
drives are all removable, you can use
as many different drives as you need.
Plus you can take advantage of the
CD-ROM drive built into every ThinkPad
Power Series model. Slots for two Type
I/II or one Type III PCMCIA™ cards let
you add even more function – modems
and Ethernet™ or Token-Ring adapters
for networking, to name a few.

Choose the one that's right for you

How do you decide which IBM
ThinkPad Power Series notebook is
right for you? If you need to maximize
performance and minimize size, the
ThinkPad Power Series 820 is your best
choice. It has all you need to run even
the most demanding 32-bit multitask-
ing applications. Plus, with its internal
CD-ROM drive, it weighs just 7.3
pounds. If you need advanced multi-
media capabilities, all the way to
video conferencing, select the ThinkPad
Power Series 850. Standard G10
graphics with motion video built in and
up to 96MB memory mean you can
handle full-motion video with ease. And
the easy-to-mount optional video
camera lets you participate in a video
conference anywhere you have
access to a phone³– from your office
or in the field.

Whichever ThinkPad Power Series
model you choose, you'll get a break-
through in professional productivity, too.
From a salesperson taking multimedia
on the road...to an oil industry engi-
neer working on an offshore rig...
to a scientist turning a home office into
a lab. It's the PC that lets you take the
power with you wherever you go.

Shift into high gear

The ThinkPad Power Series notebooks
handle floating-point-intensive applica-
tions just as effectively as advanced
desktop systems. The reason? The
PowerPC™ processor – designed by
IBM, Apple® and Motorola® – is based on
Reduced Instruction Set Computing

(RISC) architecture. So it gives you a
floating-point price/performance edge
on today's PCs – plus a platform that
can take you into the next decade and
beyond.

Putting power on display

IBM is the trendsetter in notebook
display technology – something you'll
see right away with the ThinkPad
Power Series. Our new 10.4-inch diago-
nal SVGA TFT displays give you 65,536
colors at 800 x 600 resolution. This
means you get more spreadsheet col-
umns on the screen, more colors and
a crisper display of text and graphics.
Detailed images like CAD drawings,
schematics and maps are even easier
to use. Plus, vibrant colors add excite-
ment to your presentations – and
enhance everyday applications. You
can also choose models with our more
economical – but still big, bright and
beautiful – 10.4-inch diagonal VGA
(640 x 480) TFT displays with 65,536
colors. Both feature Black Matrix tech-
nology for glare reduction and easy
viewing in virtually any light...from
almost any angle.

The power to express yourself

Every ThinkPad Power Series includes
G10 PCI local-bus graphics that pro-
vide the punch you need for a wide
range of graphics-based applications.
Art, photography and video all take
on a sharp new perspective on the
Power Series. Plus imaging and design
that once required a souped-up tech-
nical workstation can now be worked
on anywhere...from a park bench to
an airplane tray table.

Made for multimedia

IBM ThinkPad Power Series models
are designed with multimedia in mind.
Every system comes standard with
this multimedia hardware already
built-in: full 16-bit stereo business audio,
internal stereo speakers, a built-in
microphone and headphone and micro-
phone jacks. An internal SCSI-2 double-
speed CD-ROM drive is standard on
all models.

When it comes to video, the ThinkPad
Power Series is in a class by itself. With
the appropriate operating system sup-

port,* you can run advanced functions such as motion video and high-quality music using software alone. That's because the PowerPC processor, with its exceptional floating-point and signal-processing capabilities, can readily handle video and audio processing right along with your regular work.

ThinkPad Power Series notebooks with enabled operating systems* come standard with IBM's innovative software solutions for tapping this performance capability today. The IBM SoftMPEG Decoder, for example, can support MPEG video files. The IBM Video CD Player lets you view video-CD-format movies right on your notebook! And with the IBM SoftMIDI Synthesizer, a 32-multi-timbral-note wavetable music synthesizer, you can produce high-quality music for everything from multimedia presentations to customized training programs.

And that's just for starters. Both models support a motion video adapter (optional on the Power Series 820) that lets you play VCR video full screen, at full frame rates. Plus with NTSC video in/out and PAL video in (standard on the Power Series 850, optional on the Power Series 820), you can show multimedia and video presentations on a color NTSC television monitor, or capture and display video on your ThinkPad Power Series.

The result of all this is multimedia that's powerful enough for production-quality applications... affordable enough to distribute widely...and portable enough to take anywhere.

Video conferencing over a single phone line
The high performance of the PowerPC 603e microprocessor also allows you to turn your ThinkPad Power Series into a mobile video conferencing station. The optional snap-in camera mounts easily on top of the ThinkPad Power Series 850 for a total added weight of just 6 ounces. That way, you can see eye-to-eye with even the most remote road warriors – something that's sure to raise productivity among field personnel. For example, Personal Conferencing

for AIX* shipped with *every* ThinkPad Power Series AIX system with a motion video adapter–allows you to collaborate using voice, data or video conferencing over a *single* phone line³. Nowhere else can you find a more compact video conferencing solution.

Make your connection with PCMCIA cards
Every ThinkPad Power Series lets you take advantage of lightweight, power-thrifty PCMCIA cards to plug into the network connections you need... Ethernet, Token-Ring or modem. That way, mobile users can take full advantage of LAN resources at the home office – and stay connected while on the road.

Full mobility without sacrificing security
IBM ThinkPad Power Series systems perform anywhere – and they protect your data everywhere. A power-on password stops intruders from starting up your system – even when restarting from suspend mode. But if you need to share your system, don't worry. A supervisor password prevents unauthorized users from changing configuration information, system utilities or accessing restricted system functions.

Run with 32-bit operating systems
Each ThinkPad Power Series notebook can run one of four advanced multi-tasking operating systems. OS/2® Warp Connect (Power PC Edition) (planned availability 4Q95), teams ease of use, a vast selection of applications from the DOS/Windows™ world, and advanced 32-bit performance capability. ThinkPad Power Series notebooks also run the Windows NT™ Workstation 3.51 (PowerPC Edition) operating system with PCMCIA and power management support. That means notebook users can run their existing Windows applications and take advantage of advanced 32-bit Windows NT applications as well. AIX Version 4 for Clients will run a wide range of UNIX®-based business, technical and academic applications. It even

includes SoftWindows™ support. And other users of UNIX-based applications will be able to run Solaris® (PowerPC Edition) (when available) on the ThinkPad Power Series.

Taking power personally
Mobility isn't the only thing that makes the ThinkPad Power Series notebook computers special. The performance built into these notebooks opens the way for Human-Centered™ computing, IBM's direction for a new, more intuitive way of working with computers. For starters, you'll be able to speak to your system – for commands and dictation –plus your system can talk back to you. Look for exciting future innovations such as additional intelligent agents, advances in conversational computing and personal conferencing. The multimedia introduction that comes with your ThinkPad Power Series can show you what the future holds.

HelpWare service and support
Every IBM ThinkPad Power Series notebook you buy is backed by a three-year warranty with International Warranty Service.² If you ever need to use your warranty, you'll appreciate ThinkPad EasyServ™ door-to-door courier repair service,⁵ available at no additional charge during the warranty period.

What's more, with every ThinkPad Power Series you receive IBM's world-class HelpWare® customer support. Power Series experts can be reached by toll-free telephone 24 hours a day, 7 days a week at 1-800-772-2227(excluding some holidays). Electronic support services include fax (1-800-IBM-3395), bulletin board (1-919-517-0001) or online services.

Put the ThinkPad Power Series to work for you
From adding mobility to demanding line-of-business solutions to putting multimedia on the road, IBM ThinkPad Power Series notebooks have a solution for you. For information on how to put the ThinkPad Power Series to work for you, call your IBM representative or 1-800-472-7693 for an IBM Authorized Reseller near you.

Processor
- PowerPC 603e 100MHz with 32KB L1 internal cache
- 256KB L2 cache

Bus architecture
- Power Series 820: 32-bit memory
- Power Series 850: 64-bit memory

Memory
- Parity memory for data integrity
- Power Series 820: 16MB or 32MB base; 48MB maximum via sockets for 8MB or 16MB Memory Modules
- Power Series 850: 16MB or 32MB base; 80 or 96MB maximum via two sockets for 4MB, 8MB, 16MB or 32MB IC DRAM cards (installed in pairs of the same size)

Display
- SVGA: 10.4" (measured diagonally) active-matrix TFT color LCD; sidelit; 65,536 colors at 800 x 600 for superior resolution; 110:1 contrast ratio
- VGA: 10.4" (measured diagonally) active-matrix TFT color LCD; sidelit; 65,536 colors at 640 x 480 for superior resolution; 100:1 contrast ratio
- Black Matrix technology for superior viewability in bright light

Video graphics
- PCI local bus
- IBM ThinkPad Power Series G10 Graphics
- Motion video, NTSC in/out and PAL in (optional on Power Series 820)
- Power Series 850: Snap-in video camera (optional)
- Simultaneous display of LCD and external SVGA monitor

Audio
- Integrated 16-bit business audio
- Built-in microphone and stereo speakers
- IBM Personal Microphone (for speech recognition and other voice applications)

Advanced function support
These applications* plus the floating-point performance of the PowerPC processor provide advanced function without additional hardware:
- IBM SoftMPEG Decoder for viewing MPEG 1 video/audio files
- IBM Video CD Player for viewing video-CD-format movies
- IBM SoftMIDI Synthesizer for playing back high-quality music
- Speech recognition, dictation and command navigation utilizing IBM VoiceType™ technology
- IBM Human-Centered Experience for integrating actors, agents, audio, video and voice into a common interface

Storage
- Removable 540MB, 810MB, or 1.2GB SCSI-2 hard drives
- Internal SCSI-2 double-speed removable CD-ROM drive
- Internal/external 3.5-inch 1.44MB diskette drive
- Supports optional 1GB or 2GB SCSI-2 external hard drives*

*Requires External SCSI Enclosure, SCSI-2 Cable Adapter and SCSI Active Terminator plus cable

Expandability
- PCMCIA slots for two Type I/II cards or one Type III*
- Optional PCMCIA Ethernet or Token-Ring adapters, data/fax modem
- 120-pin ISA bus connector
- External SCSI-2 port

Standard I/O interfaces
- SVGA external display port (supports monitors up to 1024 x 768 resolution)
- Enhanced Parallel, serial, external keyboard/mouse/numeric keypad, external diskette drive and SCSI-2 ports
- Audio line in/out (Power Series 850 only), headphone and microphone jacks
- Motion video in (NTSC and PAL) and out (NTSC) jacks (optional on Power Series 820)

Keyboard
- Integrated TrackPoint III pointing device with QuickStop response and drag lock buttons
- 85 full-size keys
- Full key travel

Power supply
- Rechargeable NiMH Battery Pack
- Battery life can range from 2.0 to 5.0 hours'
- 1.5-hour internal quick charge in power-off or suspend mode, 2.0-hour during operation'
- 50W external worldwide AC adapter
- Optional Travel Quick Charger (Power Series 820)
- Optional Quick Charger (Power Series 850)

Dimensions
- Power Series 820: 11.7" x 8.3" x 2.2"
- Power Series 850: 11.7" x 10.2" x 2.4"

Weight
- Power Series 820: 7.3 lbs. with battery, CD-ROM
- Power Series 850: 7.9 lbs. with battery, CD-ROM
  8.3 lbs. with battery, CD-ROM, camera

Choice of operating systems
- OS/2 Warp Connect (PowerPC Edition) (planned availability 4Q95)
- Windows NT Workstation 3.51 (PowerPC Edition)
- AIX Version 4 for Clients
- Solaris (PowerPC Edition) (when available)
- Systems are also available with no operating system installed

For more information
- IBM Fax Service at 1-800-IBM-3395 (1-800-426-3395)
- Internet (http://www.austin.ibm.com/powrinfo.html)
- Online services: CompuServe* (GO: POWERPC), PRODIGY* (JUMP TO: IBM), America Online* (GO TO KEYWORD: IBM), GEnie* (page 1435, keyword PPC) or IBMLink.

APPENDIX 4F

VIDEO CAPTURE PCMCIA CARD
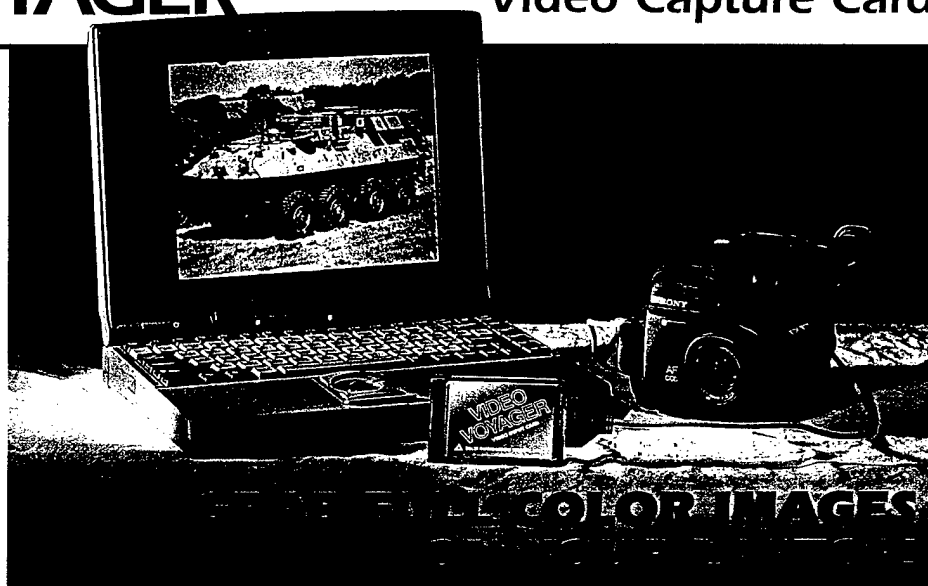
◢▲VIDEOVOYAGER

PCMCIA Video Capture Card

FEATURES

- NTSC, PAL, OR S-VIDEO INPUT
  High quality image capture

- TWO VIDEO INPUT CONNECTIONS
  Multiple system configurations

- STILL IMAGE OR MOTION VIDEO CAPTURE
  Applications Versatility

- UP TO 720 X 480 CAPTURE RESOLUTION
  Good picture detail

- INTEGRATED BRIGHTNESS, CONTRAST, HUE, SATURATION CONTROLS
  Provides WYSIWYG control

- CROPPING, SCALING, DECIMATION
  For optimal motion performance

- VIDEO FOR WINDOWS™ DRIVER
  Assures applications compatibility

- PCMCIA PLUG AND PLAY
  Easy to use–reduces installation and set-up costs

- DEVELOPER TOOLS AND OEM SUPPORT
  Short development cycles for specialized applications

- RESELLER INTEGRATION ASSISTANCE
  Solutions to market faster

IDEAL APPLICATIONS

- Photo ID and Video Fingerprinting
- Insurance Claims Processing
- Estate Inventory Logs
- Real Estate and Architectural Presentations
- Inspections
- Service Calls
- Troubleshooting
- Videoconferencing
- Multimedia Authoring
- Image Database Generation
- Industrial Control and Visual Inspection
- Plastic Surgery, Dental, Ophthalmic Preview
- Retail Cosmetic and Hairstyle Preview
- Entertainment and Novelty Systems
- Your Unique Application Is the Most Important One...

The VideoVoyager is a Type II PCMCIA card designed to interface cameras, VCR's, and camcorders to standard PC laptop computers. The unit is a plug and play type device which supports hot insertion to the laptop, automatic software recognition and configuration, and Windows GUI control.

VideoVoyager accepts NTSC, PAL, or S-Video input which can be captured as still images or motion video and stored to disk or displayed on the laptop monitor. The user can control image size (scaling, cropping and decimation) and parameters (hue, saturation, brightness and contrast) for maximum quality.

Easy to Use!

VideoVoyager installs easily into your laptop, notebook, or other PCMCIA Type II equipped computer. By connecting a video capture device, full color images can be digitized and displayed or stored to disk. It's ideal for photo IDs, inventory logs, video conferencing, image database creation, medical and cosmetic previewing, and multimedia authoring.

Complete portability, enhanced security and greater efficiency in recording and using images make VideoVoyager the ideal add-on for people on the go.

Visuals and Data in a Single Pass!

Make your field imaging easier and more accurate. Recording images with digital cameras, camcorders and other approaches requires extra work importing or linking images with related information on the computer. With VideoVoyager and the appropriate Video for Windows™ compliant applications software, pictures are stored directly to your notebook—immediately available for inclusion in FAX, e-mail, modem, network, or other transmissions. You can improve efficiency and eliminate potential errors by capturing the visuals and data together.
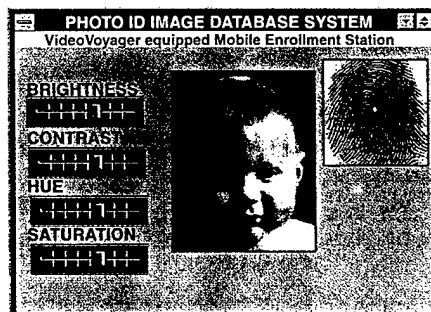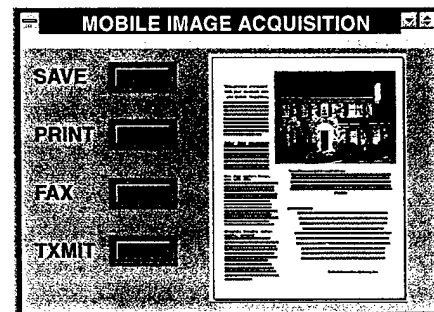
Photo ID and fingerprinting is fast and easy—a great security feature for personal and corporate use!

Visuals and pertinent data are instantly assembled in the field for increased usability and decreased factual errors.

◢▲DELTA INFORMATION SYSTEMS, INC.

300 Welsh Road, Suite 120, Horsham, PA 19044-2273
Voice (215) 657-5270   Fax (215) 657-5273

BENEFITS

COST SAVINGS

Image acquisition costs are reduced through simplified logistics, reduced transportation costs and employee expense.

SIZE AND PORTABILITY

A notebook-based image acquisition system features total portability and mobility. Where space is at a premium, the notebook system saves tremendously over desktop systems!

SECURITY

Notebook systems can easily be locked up for securing critical information.

VERSATILITY

The ability to accept a variety of high resolution editable image formats makes VideoVoyager the image acquisition system of choice for a wide range of applications.

ABOUT DELTA

Delta Information Systems, Inc. has successfully implemented solutions in image processing, video compression, and other digital visual communications applications since 1976.

Significant achievements include very high frame rate—up to 240 frames-per-second—capture and high resolution 30 fps compression.

Delta is actively involved in emerging standards in video-conferencing, compression, and telecommunications. Services range from research and development, product design, and engineering to manufacturing and testing—including assistance with standards compliance.

Please call the Applications Engineers at Delta today for more information on the VideoVoyager and for information on our other products and capabilities.

SPECIFICATIONS

VIDEO

Input Formats	NTSC, PAL, S-Video (software selectable)
Capture Formats	16 bit YCbCr 4:2:2
	24 bit RGB
	8 bit grayscale
Picture Size	Still Image Resolution - up to 720 x 480
	Motion Video Resolution - up to 720 x 480
Motion Capture	Frame Capture Rate - up to 30 frames/sec
	(resolution & system dependent)
Software	Video for Windows™ compliant device driver

CONTROL/STATUS

Control Functions	Normal/Power-Down Operation
	Input Port Select
	NTSC/PAL Auto-Detect
	Image Scaling, Cropping, Decimation
	Hue, Contrast, Brightness, Saturation
	Luma/Chroma Gain
	Still Image/Motion Capture Mode
	Capture Enable

MEMORY

Field Buffers	1 MB RAM - 256k x 16 x 2 (odd & even fields)

PHYSICAL CHARACTERISTICS

PCMCIA Type II PC Card	85.6mm x 54mm x 5mm
	68 pin standard female host connector
	15 pin female video connector
	Includes video adaptor cable
Power Requirements	Voltage: 5V ± 10%
	Operating Current: 250 mA

Other Products Offered by DELTA INFORMATION SYSTEMS

DESTEL	Desktop Video Conferencing System
VCM	Video Compression/Decompression Modules and Systems
EVOSS	High Frame Rate Video Compression Systems
RSC	Video Scan Converter

Call Delta today for information on the VideoVoyager, and for more information on our other products and capabilities.

APPENDIX 4G

PRESS RELEASE DESCRIBING MATSUSHITA/PANASONIC's NEW WIRELESS VTC PRODUCT

Matsushita Develops the World's First Cordless Videophone
Based On Personal Handyphone System (PHS)

-- realizing real-time two-way communication of
both color moving pictures and speech --

Matsushita Electric Industrial Co., Ltd. of Osaka, Japan, announced the development of the world's first cordless videophone system, which achieves real-time, person-to-person communication with both audio and color moving images. The new videophone is compatible with Japan's Personal Handyphone System(PHS)(*1).

As a future expansion of PHS, a variety of mobile multimedia applications, including the cordless videophone, have been anticipated. For this purpose, it became essential to develop technology to transmit color moving images through PHS wireless channels.

However, since the bandwidth of individual PHS channels is only 32 kbps, the H. 261 codec(*2), which is a standardized high compression rate coding system, has to be employed. But, higher

- 2 -

transmission error rates and severe error-rate fluctuations are inevitable when a radio transmission line, such as these for PHS, is used, in comparison with using a wired line. This can cause problems of severe deterioration of picture quality and severe transmission delays.

These problems are solved by the development of (1) an error-free transmission line system incorporating an automatic repeat request (ARQ) feature(*3) in the wireless transmission stage, and (2) a system preventing the deterioration of picture-quality and maintaining low delay time to combat throughput variance caused by transmission errors through the optimization of the H. 261 coding parameters at the point of transmission.

The features of the cordless videophone realized by these technologies are as follows:

1.   Transmission of high-quality color moving pictures
      (equivalent to that available by wire-line transmission)
      through the use of the PHS system.

2.   Battery-operated portable handset with 2.5-inch color LCD
      screen.

3.   Further progress in the development of mobile multimedia by
      combining functions of a notebook PC, Personal Digital
      Assistant and other devices.

Matsushita plans to work on the systemization of this technology within a private branch exchange(PBX). Additional targets include reduction of power consumption and

- more -

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miniaturization to make private multimedia systems practical. In
the future, we expect to apply this technology in the public PHS
network in Japan and in other countries around the world.

This cordless videophone as well as a notebook PC-based PHS
multimedia system will be displayed at Telecom '95, which will be
held this October in Geneva. Related papers will be presented at
a Telecom '95 technical forum.

A total of 24 domestic and three overseas patents are being
applied for.

Technology

The Cordless Videophone is realized by using the following
new key technologies:

(1) Error-free transmission by employing ARQ in the PHS wireless
    stage.

Burst-errors due to slow fading (*4), which is a problem
particular to PHS, can be efficiently corrected by employing the
ARQ system. By employing ARQ processing system software, a
compact and lightweight cordless videophone has been developed.

Although burst-errors lasting for several tens of milliseconds
are likely when PHS is moved at a walking speed, these can be
totally corrected by the ARQ retransmission. Since this makes
possible a considerably higher efficiency than possible with
forward error correction(FEC)(*5), transmission of moving
pictures with higher quality becomes possible.

- more -

(2) Control of H. 261 coding at transmitter

H. 261 coding at the transmitter is adapted to the effective transmission rate, fluctuating according to the transmission errors.

Both the prevention of subjective picture-quality deterioration and the low delay time are realized by applying optimal compensation. The H. 261 encoder determines the optimum combination of the frame rate per time and, the spatial resolution at the effective transmission rate derived from the frequency of ARQ retransmissions.

Features of developed product:

The features of the cordless videophone developed are as follows:

1. Transmission of high-quality color moving pictures through PHS system

The deterioration of subjective picture-quality and the large delay of pictures are prevented by employing ARQ and optimizing the H. 261 coding control. As a result, transmission of moving color pictures is possible in the same type of areas where PHS cordless telephones are usable.

Prior to standardization, Matsushita developed a new 64 Kbps transmission system using two channels of PHS simultaneously. Since the cordless videophone uses one PHS channel each for speech and moving pictures, communication by the cordless videophone with a conventional PHS cordless telephone is also possible.

2. Battery-operated portable handset with 2.5-inch LCD screen

In order to realize a portable PHS handset, the volume of hardware is substantially reduced by using a software realized on a high-performance digital signal processor that can conduct both H. 261 image processing and ARQ protocol processing, and making digital interfaces for the input/output devices of the camera and the liquid-crystal display.

3. By integrating this PHS videophone with notebook PCs and PDAs, a wide range of mobile multimedia will become available.

- more -

By incorporating this cordless videophone into a notebook PC, a video conference can be held, sharing common data. Integration with a PDA is expected in the future.

- **Specifications**

Coding System:	Video	H. 261 (32 kbps)
	Speech	G. 721 (32 kbps)

Transmission Control: HDLC
Resolution: 176 x 144 (QCIF)
Frame/sec.:   3 - 7 frames/sec.
Delay time of images: within 500 ms
Display: 2.5" color liquid crystal display panel
                              (55 mm x 43 mm)
Camera: 1/3" CCD
External Dimensions: 85 mm x 219 mm x 46 mm
Weight: 560 g (Body: 500 g, Battery: 60 g)
Function: Picture-in-Picture
                          Still mode/Holding mode
                          High-resolution mode(352 x 288)

Glossary of Terms

(*1) PHS (Personal Handyphone System: Second generation cordless phone system)

PHS is a personal communication system that has been standardized in Japan. In addition to use at home and in the office, access to public telephone lines is possible. Public service began in July 1995. Data transfer speed by PHS is 32 K bit/sec. (Public service is limited to speech system only. Extension to data transmission and multimedia service is still pending.)

(*2) H. 261

The International Standard (ITU recommendation) for video coding of moving picture communication in the 64 kbps to 2 Mbps bit rate range.

(*3) ARQ(Automatic Repeat Request)

ARQ is a technique for correcting errors generated in transmission lines; it requests repeated retransmission through

the feedback line upon detecting any error at the receiver.
Although higher transmission reliability can be obtained by
repeating the retransmission, the throughput of the transmission
line is sacrificed.

(*4) Slow fading

This is one of the receiving level fluctuations causing burst
errors. The transmission error rate in a radio transmission line
is generally higher than that of a wired line, $10^-2 - 10^-3$.
Moreover, it is characterized by large fluctuations.

In the PHS frequency band(1.9GHz), the Doppler frequency
corresponding to human walking speed(3km/h) is 5Hz. Thus, the
frequency of single digit transmission error deterioration is
about 3.5 cycles/sec. This causes a slow fading with an average
duration of 20 ms.

(*5) FEC(Forward Error Correction)

An error control system that detects and corrects errors
generated in transmitting and receiving coded information by
means of error correcting codes. Since the prediction of large
fluctuations of wireless transmission line characteristics is
impossible, adequate reliability is very difficult to obtain by
FEC alone.

Information for Editors

Panasonic and Technics are brand names for Matsushita Electric
Industrial Co., Ltd., one of the world's largest manufacturers
of electronic and electric products for consumer, business and
industrial use, and ranked 17 in the Fortune 500 Last year,
Matsushita formally became a member of the International
Telecommunications Union. Matsushita's annual sales for the
financial year ended 31 March, 1995, totalled $78.07 billion.

In Europe, Panasonic has 12 sales and 19 manufacturing companies, and employs around 10,000 people. Joint European ventures include Siemens (electronic components), Philips (batteries) and Bosch (VCRs).

Products sold under the Panasonic brand include a wide range of sophisticated electronics and electrical merchandise from consumer goods (TVs, video recorders, Hi-Fi equipment and microwave ovens) to office equipment (photocopiers, printers, telephone systems, etc) and a variety of industrial material, components and machines.

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